GEOMAR REPORT

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Helmholtz-Zentrum für Ozeanforschung Kiel

RV SONNE Fahrtbericht / Cruise Report SO258/1

INGON: The Indian - Antarctic Break-up Engima

Fremantle (Australia) - Colombo (Sri Lanka)
07.06.-09.07.2017

Berichte aus dem GEOMAR
Helmholtz-Zentrum für Ozeanforschung Kiel

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CONTENT

1. Cruise Summary 2
1.1. English 2
1.2. German 3
2. Participants 4
2.1. Ship´s Crew 4
2.2. Principal Investigators 4
2.3. Shipboard Scientific Party 4
2.4. Institutions 5
3. Narrative of the Cruise 5
4. Aims of the Cruise 12
4.1. Profiling and Rock Sampling 12
4.2. Biological Investigations 13
4.2.1. Experiments carried out as planned 13
4.2.2. New and additional experiments 15
5. Agenda of the Cruise 16
5.1. Geological Investigations 16
5.2. Biological Investigations 18
6. Introduction in the working Area 19
6.1. The Gondwana Break-up and the Dispersal of India / Sri Lanka 19
6.2. The 85°E Ridge 19
6.3. The EM 1 Mantle Component at Afanasy Nikitin 21
6.4. Biology 21
7. Methods and Description of Stations 23
7.1. Profiling and Rock Sampling 23
7.1.1. Methods 23
7.1.1.1. Bathymetry (Kongsberg Maritime EM122) 23
7.1.1.2. Sediment Echo-Sounding (Atlas PARASOUND P70) 25
7.1.1.3. Dredging, Site Selection, and Laboratory Work 26
7.1.2. Rock Sampling Report and Preliminary Results of Bathymetric Mapping 27
7.1.2.1. Osborn Seamount 27
7.1.2.2. 85° Fracture Zone 29
7.1.2.3. "Southern Seamounts" 30
7.1.2.4. Afanasy Nikitin Complex 33
7.1.2.5. Buried Hills 38
7.2. Biological Investigations 41
7.2.1. Methods 41
7.2.1.1.Tucker Trawl 41
7.2.1.2. Neuston Net Catches 42
7.2.1.3. Lander Types and Deployments 42
7.2.2. General Description of Catch 43
7.2.3. Investigations and Experiments with Fish, Cephalopods and Crustaceans 45
7.2.3.1. Visual Ecology and Sensory Systems in Deep-Sea Fishes from a Brain Perspective 45
7.2.3.2. Mesopelagic Fish Sexual Dimorphism and Visual Ecology 46
7.2.3.3. Transcriptomics of Mesopelagic Fish 46
7.2.3.4. Collaborative Fish Work 46
7.2.3.5. Visual Pigment Regeneration 47
7.2.3.6. Stomiid Vision 49
7.2.3.7. Tubular Eyes in Mesopelagic Fish: Advantages, Drawbacks, and Ways to Overcome them 50
7.2.3.8. Circadian Rhythms in Mesopelagic - Vertical Migrating Fish 51
7.2.3.9. Sensory Input to the Central Nervous System 52
7.2.3.10. Lateral Line Ultrastructure and Ecology 53
7.2.3.11. The Auditory Abilities of Mesopelagic Fishes 54
7.2.3.12. Shrimp Spectral Sensitivity 56
7.2.3.13. Visual Ecology and Neuronal Function in Cephalopods 57
7.2.3.14. Free-Falling Autonomous Landers 60
8. Acknowledgements 65
9. References 66

Appendices:

I. Sampling Summary / Station List
II. Rock Description Table
III. 3D-Maps of SO258 Leg 1 Dredges Tracks
IV. Tucker Trawl Deployment Data
V. List of Teleost Fish Recovered from Trawls
VI. List of Cephalopods Recovered from Trawls
VII. List of Shrimp Caught or Used for Crustacean

1.1 SUMMARY

The R/V SONNE expedition SO258 leg 1 is part of the research project INGON, which is a collaboration between the Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI) and the GEOMAR Helmholtz Centre for Ocean Research Kiel. Using the example of the Indian-Antarctic Break-up in Early Cretaceous, SO258 INGON aims to investigate magmatic and tectonic processes that trigger the break-up of continents and the formation of ocean basins. This is not only an important topic in basic research contributing to a better understanding of the Earth system but also provides important data on the relations between magmatic and volcanic activity and their influence on environment, climate, and ecological systems. Cruise SO-258 leg 1 mapped and sampled magmatic structures in the central Indian Ocean between 82° und 86°E using a KONGSBERG EM 122 echo-sounding system, a ATLAS PARASOUND DS P70 sub-bottom profiling system, and chain bag dredges. The main working areas were the "Southern Seamounts" (working name given by the cruise participants) at 08° - 11°S, the Afanasy Nikitin Ridge and Seamount, and the Buried Hills at 3°-5°N. A total of 39 dredge hauls in an average water depth of 4,150 m were carried out on SO258 leg 1. Of these, 32 (= 82%) delivered *in situ* samples of which 29 obtained lava, 15 volcaniclastics, and five sedimentary rocks. No equipment was lost or seriously damaged. The on shore work program at GEOMAR and cooperating institutions will include geochronological, petrological and geochemical studies on igneous samples obtained during the cruise. Integration of the results of SO258 leg 1 with those of geophysical investigations (seismic, magnetic, gravity) conducted by the AWI on SO258 leg 2 will substantially improve our understanding of geodyanamic evolution of the Indian Ocean.

In addition to the geological investigations, on SO258 leg 1 biological studies by the University of Tübingen and partners have been carried out which focus on the ability of deep sea fish, squid, and shrimp to see bioluminescent light in the darkness of 500 - 1,500 depth. The visual images created by bioluminescence are much different from the general, scenic illumination resulting from sunlight; rather they constitute patio-temporal pattern of glowing dots. This special optical environment has lead to the evolution of special adaptations in the visual systems, and the eyes in particular. The eyes of mesopelagic squids, cephalopods, crustaceans and teleosts have been studied to investigate their morphological and physiological adaptations and specialisations for the perception of bioluminescence. Tubular eyes play an important role in this respect, and these are found in squid and fish, as a result of convergent evolution. We have compared species with tubular eyes to those with normal eyes (*Argyropelecus* vs. *Sternoptyx*) in order to analyse their functional advantage, and further studied the role of optical devices such as mirrors, optical folds, lens pads and diverticula, that enlarge the otherwise restricted visual field of tubular eyes. In a series of biochemical and morphological experiments we have tested the ability of mesopelagic retinae to regenerate their visual pigment (rhodopsin) after controlled bleaching. In addition, the function and potential impact on behaviour of additional sensory systems was also investigated: For the first time ever, auditory recordings were obtained from mesopelagic fish and their frequency sensitivity characterized. Still another set of experiments investigated the molecular expression of clock genes and the importance of endogenous rhythms in mesopelagic fish. Finally, autonomic lander systems fitted with baited cameras or traps were deployed to study the influence of depth and pressure on the composition of hadal fish and amphipod communities in locations far removed from hadal trench ecosystems. In total, the 25 trawls conducted with a net specially designed to fit the A-frame of the new „Sonne“ contained far more than 2,000 specimens of fish from 38 families, and 81 genera, 225 specimens of cephalopod from 17 families and 27 genera, and 75 specimens of crustacean from 16 families/genera, indicating that our catches were very successful. A systematic analysis of the transcriptomes of teleosts and cephalopods will be carried out, and the brains and eyes processed for microscopic analysis in the respective home labs.

1.2 ZUSAMMENFASSUNG

Die FS. SONNE-Expedition SO258 Leg 1 ist Teil des Forschungsvorhaben SO258 INGON, das vom Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung (AWI) und dem GEOMAR Helmholtz-Zentrum für Ozeanforschung Kiel gemeinsam durchgeführt wird. Mit SO258 INGON soll am Beispiel der Abtrennung Indiens von der Antarktis in der frühen Kreide untersucht werden, welche Mechanismen beim Auseinanderbrechen von Kontinenten und der Bildung von Ozeanbecken eine Rolle spielen und welche magmatischen Prozesse dabei im Erdmantel ablaufen. Dies ist nicht nur ein wichtiges Thema in der Grundlagenforschung, indem es zu einem besseren Verständnis des "Systems Erde" beiträgt, sondern damit werden auch grundlegende Daten über die Zusammenhänge zwischen magmatischer, vulkanischer und tektonischer Aktivität und deren Einfluss auf Umwelt, Klima- und Ökosysteme gewonnen. Während SO258 Leg 1 wurden magmatische Strukturen im zentralen indischen Ozean zwischen dem 82. und dem 86. Längengrad mit dem KONGSBERG EM122 Fächerecholotsystem kartiert und mit Kettensackdredgen beprobt. Daneben wurden umfangreiche Profilierungen mit dem PARASOUND DS P70 Sedimentecholot vorgenommen. Die geologischen Arbeiten konzentrierten sich auf drei Gebiete: (1) die "Southern Seamounts" (Arbeitsname vergeben durch die Fahrtteilnehmer/innen) im Bereich zwischen ca. 08° und 11°S, (2) den nördlich davon gelegenen Afanasi Nikitin Komplex und (3) die Buried Hills im Bereich zwischen 3° und 5°N. Insgesamt wurden 39 Dredgezüge durchgeführt, von denen 32 (= 82%) *in situ* Proben (29 Laven, 15 vulkaniklastische Gesteine und fünf Sedimentgesteine) erbrachten. Es wurde keine Ausrüstung verloren oder nennenswert beschädigt. Die auf SO258 Leg 1 gewonnenen Proben werden am GEOMAR und bei unseren Kooperationspartnern, petrologisch, geochemisch und geochronologisch bearbeitet. Die Ergebnisse von SO258 Leg 1 werden mit denen der Reise SO258 Leg 2, auf der geophysikalische Untersuchungen (Seismik, Gravimetrie, Magnetik) durch das AWI durchgeführt wurden, integriert.

Zusätzlich wurden während SO258 Leg 1 biologische Fragestellungen durch die Universität Tübingen und deren Kooperationspartner untersucht. Im Zentrum stand dabei die Fähigkeit von Meeresorganismen, das von ihnen erzeugte Licht (Biolumineszenz) wahrzunehmen. Die visuellen Bilder, die durch Biolumineszenz entstehen, unterscheiden sich grundsätzlich von der uns vertrauten szenischen Beleuchtung durch das Sonnenlicht; sie stellen vielmehr räumlich-zeitliche Muster von leuchtenden Punkten dar. In der Evolution sind daher eine Reihe von speziellen Anpassungsmechanismen des visuellen Systems an diese Situation entstanden. Wir haben die Augen von mesopelagischen Cephaloloden, Crustaceen und Teleostiern untersucht und die dort vorkommenden morphologischen und physiologischen Anpassungen und Spezialisierungen an die Wahrnehmung der Biolumineszenz charakterisiert. Teleskopaugen spielen dabei eine wichtige Rolle; sie kommen bei Tintenfischen und bei Knochenfischen vor und stellen ein Beispiel für konvergente Evolution dar. Wir haben untersucht, wie zusätzliche optisch aktive Strukturen wie Divertikel mit Spiegelkristallen und “Linsen-Polster“ (lens pad) dazu beitragen, das eingeschränkte Gesichtsfeld der Teleskopaugen zu erweitern. In einer biochemischen Versuchsserie haben wir die Fähigkeit der Netzhäute mesopelagischer Fische untersucht, ihr visuelles Pigment, Rhodopsin, nach Bleichung durch intensives Licht wie es z.B. von ROVs benutzt wird, zu regenerieren. Auch die Funktion und der Einfluss auf das Verhalten von anderen sensorischen Systeme wurde untersucht: Zum ersten Mal überhaupt gelang es, das Hörvermögen mesopelagischer Fische in Hirnstamm-Summenableitungen (EUGs) zu bestimmen. Weitere Experimente beschäftigten sich mit der Expression von „clock genes“ und damit der Bedeutung der „inneren Uhr“ für mesopelagische Fische. Schließlich wurden autonome Lander-Plattformen an 17 Stationen ausgesetzt, die mit ihren beköderten Kameras und Fallen den Einfluss von Tiefe bzw. Druck auf die Zusammensetzung der hadalen Lebensgemeinschaften untersuchten. Insgesamt wurden 25 Trawls durchgeführt mit einem neuen Netz, welches speziell für den Heckgalgen der neuen „Sonne“ dimensioniert wurde. Die Fänge waren sehr erfolgreich und enthielten weit über 2.000 Fisch-Exemplare mit 150 Arten, aus 81 Gattungen und 38 Familien; bei den Cephalopoden 225 Exemplare (33 Arten, 17 Familien, 27 Gattungen) und 75 Crustacen-Exemplare aus 16 Familien/Gattungen. In den Heimatlaboren wird eine systematische Analyse der Transkriptome von Teleostiern und Cephalopoden durchgeführt sowie die gesammelten Proben für die Mikroskopie aufbereitet.

2. PARTICIPANTS

2.1. SHIP'S CREW

Meyer, Oliver	Master	Schüler, Achim	Chief Engin.
Birnbaum-Feteke, Tilo	Chief Mate	Genschow, Steffen	2nd Engineer
Büchele, Ulrich	2nd Mate	Kasten, Stefan	2nd Engineer
Hoffsommer, Lars	2nd Mate	Bredlo, Björn-Alexander	Motorman
Großmann, Matthias	Chief Electronician	Hoffmann, Georg	Motorman
Meinecke, Stefan	Electronician	Blaurock, Andre	Motorman
Borchert, Wolfgang	System Operator	Yaylagül, Deniz	Motorman
Reize, Emmo	System Operator	Bolik, Torsten	Fitter
Walther, Anke	Surgeon	Adam, Patrick	Electrician
Stöcker, Frank	Chief Cook	Lemm, Rene	Chief Steward
Lohmann, Christian	2nd Cook	Carolino, Bernardo	Steward
Kraft, Jürgen	Boatswain	Steep, Maik	Steward
Scholz, Oliver	A.B.	Yan, Ingthao	Steward
Brüdigam, Benjamin	A.B.	Heibeck, Frank	A.B.
Doliwa, Jannik	A.B.	Gieske, Ralf	A.B.
Koch, Stefan	A.B.	Kuszona, Torsten	A.B.

2.2. PRINCIPAL INVESTIGATORS FOR SO258 LEG 1 INGON *(in alphabetical order)*

Collin, Shawn (Biology)	UWA
Douglas, Ronald (Biology)	CUL
Frank, Tamara (Biology)	NOVA
Geldmacher, Jörg (Geology)	GEOMAR
Hauff, Folkmar (Geology)	GEOMAR
Hoernle, Kaj (Coordinator Geology)	GEOMAR
Jamieson, Alan (Biology)	NCL
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Partridge, Julian (Biology)	UWA
Wagner, Hans Joachim (Coordinator Biology)	UT
Werner, Reinhard (Geology)	GEOMAR

2.3. SHIPBOARD SCIENTIFIC PARTY *(in alphabetical order)*

1. Fanny de Busserolles	Myctophid brains	UQ
2. Lucille Chapuis	Fish Hearing	UWA
3. Wensung Chun	Net Driver, Cephalopod vision	UQ
4. Shaun Collin	Fish Visual System	UWA
5. Fabio Cortesi	Myctophid Mol. Biol.	UQ
6. Nick Cuomo	Landers	NCL
7. Tamara Frank	Crustcean ERG	NOVA
8. Nina Furchheim	Rock Sampling /Macro Benthos	MfN
9. Folkmar Hauff	Shift Leader Geology	GEOMAR
10. Silke Hauff	Rock Sampling	GEOMAR
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12. Anna-Lee Jessop	Fish ERG	UWA
13. Karin Junge	Rock Sampling	GEOMAR
14. Stephan Homrighausen	Shift Leader Geology	GEOMAR
15. Nora Krebs	Rock Sampling	GEOMAR
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17. Thomas Linley	Landers	NCL
18. Thomas Lisney	Fish Brains	CEFE
19. Alastair Mac Even	TV Crew	Silverback TV
20. Julia Marinova	Guest Geology	IO RAS

21. Justin Marshall	Net Driver, Lateral lines	UQ
22. Ulrich Mattheus	Chemicals Resp.; Histology	UT
23. Katharina Pank	Rock Sampling	GEOMAR
24. Julian Partridge	Pigment Regeneration	UWA
25. Olly Scholey	TV Crew	Silverback TV
26. Maxim Portnyagin	Shift Leader Geology	GEOMAR
27. Inga Steindal	Biological Rhythms	UCL
28. Ann-Marie Völsch	Rock Sampling	GEOMAR
29. Hans-Joachim Wagner	Deputy PSO/Head Biology	UT
30. Luise Wagner	Rock Sampling	GEOMAR
31. Reinhard Werner	Chief Scientist	GEOMAR
32. David Whitmore	Biological Rhythms	UCL
33. Henry Zieske	Rock Sampling	Piahowiak/ GEOMAR

The SO258 leg 1 Shipboard Scientific Party. (Photo: Emmo Reize)

2.4. INSTITUTIONS

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UQ University of Queensland St Lucia, Sensory Neurobiology Group , Queensland Brain Institute, Brisbane Queensland 4072, Australia
UT Universität Tübingen, Anatomisches Institut, Österbergstr. 3, 72074 Tübingen, Germany
UWA The University of Western Australia, Oceans Insitute, 35 Stirling Hwy, Crawley 6009, W. A., Australia

3. NARRATIVE OF THE CRUISE

(R. Werner, H.-J. Wagner)

R/V SONNE Cruise SO258 leg 1 started in Fremantle, close to Perth, which is located at the southwest coast of Australia. On Monday, June 5th, in the course of an Open Ship event the citizens of Perth and Fremantle had the opportunity to visit the SONNE and get an insight into current research. The vessel, as well as the presentations of the different scientific working groups, attracted 3,200 (!) visitors and received and enthusiastic response by the public and the media.

Fig. 3.1: R/V SONNE leaving the port of Fremantle on the evening of June 7. (Photo: Nina Furchheim)

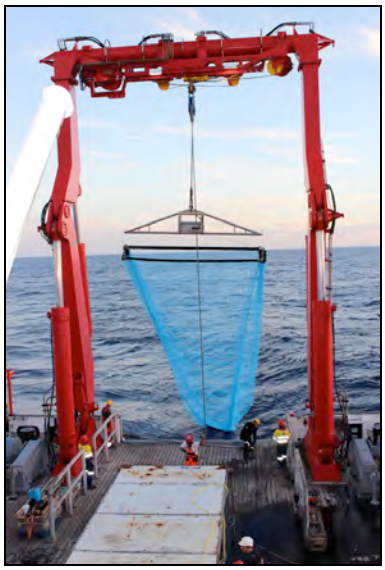


Fig. 3.2: Tucker trawl deployment. (Photo: Nina Furchheim)

In the morning of June 6th, the SO258 leg 1 scientific party embarked R/V SONNE. In total the group counted 33 scientists and technicians from 10 different countries (Australia, Great Britain, U.S.A., Switzerland, France, Taiwan, Canada, Russia, Norway, and Germany). After the arrival of all containers on board, the vessel left Fremantle in the evening of June 7th to head to its first working area (Fig. 3.1). The first priority on the transit was to set up all biological laboratories and to carry out a dry run of the biological experiments since the first part of the cruise was, besides underway mapping, exclusively dedicated to biological work. Before the setup of all laboratories and equipment, two internal meetings were held so that all participants had a chance to get to know each other and learned about the planned work. Soon enough the new Trucker-Trawl net (with an opening area of 45 m^2) was mobilized and tested (Fig. 3.2). It weighs approximately 1 t and was deployed over the stern of the vessel. A special feature of the net is that the opening can be opened and closed at depths by a control box. Although dry runs with the opening system were successful, the control box did not work during the first trawl on Friday evening as the net was still closed when it came on board and therefore caught only small amounts of krill (Fig. 3.3). On June 10th, two more trawls were carried out approximately 500 nautical miles (nm) off the west coast of Australia. To avoid previous problems, the net was deployed open this time and was initially lowered to 700 m depth and then raised in steps of 50 m every 30 minutes. After 3 to 5 hours the net was recovered on deck. Both catches were highly

successful and yielded different and rare species of fish, squid, octopus and shrimp. The last trawl was brought in after sunset, avoiding bleaching of the fish and shrimp eyes in order to allow biochemical and physiological experiments on the visual systems. During the first week of the cruise, the weather has been mostly sunny and warm. Only on Saturday we passed a low pressure area and the weather turned cloudy and a bit rainy.

Fig. 3.3: Biologists and geologists have a first look at the outcome of the first trawl. (Photo: Nora Krebs)

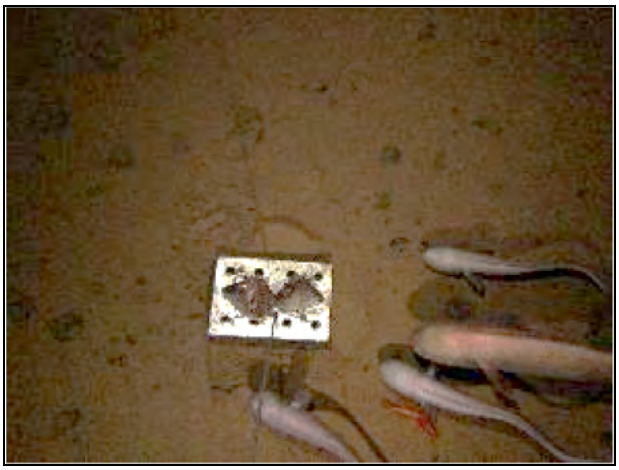


Fig. 3.4: A still image showing the cusk eels *in situ.* (photo: Newcastle University)

The second week of SO258 leg 1 was characterized by different biological experiments and the long transit to the first working area of the geologists. On the one hand, the series of trawls was continued with nine further deployments. Catches were brought on board during darkness so damage to the eyes or bleaching of visual pigments was avoided. All trawls contained numerous and diverse species of fish and also an unexpected richness in squids, octopuses, and shrimp. From Sunday to Wednesday, the Newcastle University fleet of five benthic lander were deployed 11 times between 4,700 and 6,500 m in the vicinity of a deep seafloor depression at 22˚S by 110˚E. The landers are a combination of baited video and still camera landers and baited traps. The team successfully collected specimens of amphipods from all baited trap stations including two sets of samples from as deep as 6,500 m. The landers were also used to characterize the benthic scavenging fauna and revealed a complete absence of the typical scavenging macrourids, but rather a community dominated by the cusk eel *Bassozetus* sp. (Fig. 3.4) and large natant decapods. Interestingly, on the video systems second deployment, the footage revealed that the seafloor was in fact a manganese nodule field. This week the weather was unsettled and occasionally rainy and windy. However, not least thanks to the efforts of the master and the crew of R/V SONNE we were able to conduct almost all deployments as scheduled despite wind and waves.

At the beginning of the third week, cruise SO258 leg 1 conducted further trawls before the series of Tucker Trawl deployments was discontinued until reaching the Afanasy Nikitin Seamounts area. The last trawls were short (4h) and shallow (200 m, at night) and brought a big squid (*Octopoteuthis sicula*), many smaller live squids, and apart from the usual complement of hatchetfish, and viperfish, two rare and interesting fish: a juvenile *Dolichpteryx* and a larval *Opisthoproctus*. Plankton net deployments during dredge stations caught flying fish which served as controls (surface dwelling) for the auditory experiments on deep-sea species.

During the night from Sunday, June 18th, on Monday, we arrived at Osborn Seamount. where the first two dredge hauls of this journey were conducted at its southern flank. This circular (Ø 250 km!), approximately 2,500 m high seamount is located at ~15°S directly west of the Ninetyeast Ridge, a prominent ridge structure which stretches across the entire Indian Ocean in N-S direction. The seamount has been named after the cable ship SHERARD OSBORN, which discovered and delineated it in June, 1900. Our dredges indeed returned the first rocks ever sampled from this feature but unfortunately they comprised only altered volcaniclastic rocks. En route to our first major dredge area, we stopped at the "85° Fracture Zone" which shows a

prominent morphology with a steep eastern slope between 7°S and 15°S. Despite difficult weather conditions, we were able to recover lava fragments and intrusive rocks (gabbro).

In the evening of Friday, June 21st, R/V SONNE reached a completely unexplored area. Here the predicted bathymetry shows some seamounts and ridge structures scattered between 8°S and 11°S, which have been named "Southern Seamounts" by the cruise participants. They represent the southern tip of a chain of geomorphological features called "85°E Ridge", which extends from Sri Lanka to the south and includes the Afanasy Nikitin Complex. The 85°E Ridge is the major target of the geological studies of SO258 leg 1. Our survey of the "Southern Seamounts" revealed that they comprise at least 10 circular or oval, up to 2,000 m high features, measuring up to 20 km in diameter, and numerous smaller volcanic structures (Fig. 3.5). Sampling of these volcanoes proved difficult because obviously they are covered with manganese crusts and volcaniclastic material. Nevertheless we managed to obtain lava fragments from seven of the larger seamounts (Figs. 3.6 and 3.7). Surprisingly fresh volcanic glass persisted on some of the lava fragments, which is particular suitable for geochemical analyses. When R/V SONNE headed towards the Afanasy Nikitin Complex on Saturday, June 24th, we were astonished to realized that a chain of somewhat smaller, up to 1,500 m high seamounts emanates from the "Southern Seamounts" at least 150 km in northern direction. These seamounts are not displayed by the predicted bathymetry. An attempt to sample one of these newly discovered volcanoes unfortunately yielded only crusts and heavily altered lava fragments. In the night from Saturday to Sunday SONNE sailed to the Afanasy Nikitin complex and therefore no deployments of our devices were scheduled. That provided an excellent opportunity for the midway party, enjoyed by both crew and scientists. On Sunday, June 25th, we reached the Afanasy Nikitin Complex, which has been discovered as recently as in 1959 by the Russian research vessel VITIAZ. This submarine mountain consists of a ~400 km long and up to 140 km wide basal ridge, which rises from ~5,000 m below sea level (b.s.l.) to 2,000 m b.s.l. Several seamounts up to 2,000 m high and with a maximal base diameter of 25 km are located on the northern portion of this ridge. One of these seamounts has been named after the Russian explorer Afanasy Nikitin, who traveled in the 17th century amongst others to India, the Orient, and Africa. The weather remained variable during the third week of the cruise with a mixture of clouds, sun, and rain showers.

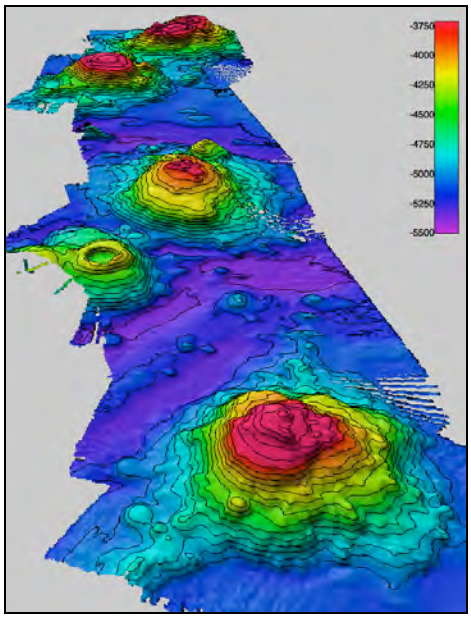


Fig. 3.5: The southern part of the "Southern Seamounts", which have been mapped for the first time on this journey. The flat tops and circular depressions (up to 2.5 km in diameter) are typical features of this seamount province.

Fig. 3.6: A chain bag dredge returns on board R/V SONNE with rocks from the ocean floor at 4,600 m water depth. (Photo: Luise Wagner)

Fig. 3.7: A dirty business: All rock samples are cut on board in order to allow better classification and to prepare them for the analyses in the home labs. (Photo: Nina Furchheim)

In the fourth week the geological studies focused on the Afanasy Nikitin Complex. Until Friday, June 28th, we carried out altogether 11 deep dredge hauls at fault scarps and the flanks of the basal ridge, of which nine recovered lava fragments and often also volcaniclastic rocks. Aphyric, olivine-phyric, olivine+feldspar-phyric, and with up to 50% plagioclase extreme feldspar-phyric varieties dominated among the lavas. Fortunately we frequently found unaltered volcanic glass in the dredges. On Saturday, July 1st, we reached the area with the large seamounts in the northern section of the ridge. Afanasy Nikitin Seamount and a nearby seamount on the eastern flank of the ridge are so-called guyots. Guyots are seamounts that have steep sides and a relatively flat summit and usually represent volcanoes that once formed ocean islands. Unfortunately two dredge hauls at the guyot on the eastern flank yielded only semi-consolidated limestone. By contrast a dredge haul at a fault scarp at the base of the northern part of the ridge returned aphyric lava and volcaniclastic rocks which fortunately exhibited again fresh glassy margins. Dredging at the Afanasy Nikitin Seamount was also successful. Here the dredge recovered vesicular lava with partly fresh glassy rims from a volcanic cone on its western flank. Finally three dredge hauls at its northern tip of the Afanasy Nikitin Complex delivered lava fragments and volcaniclastic rocks (Fig. 3.8).

Fig. 3.8: Scientists evaluate rock samples recovered at the southern tip of the Afanasi Nikitin Complex. (Photo: Nina Furchheim)

Fig. 3.9: Catches of the trawls: Top: Barbled dragonfish *Foliacanthus sp.*; detail: luminous organ at the tip of the barbel; head with photophores. Bottom left: Hatchetfish *Sternoptyx sp.*; right: Anglerfish. (Photo: Wensung Chung)

The biologists carried out ten more trawls in the area of the Afanasy Nikitin Complex. In this area of complex seafloor topography there are upwelling currents that improve the supply of nutrients for the macrofauna and raise the chances for rich and interesting catches in our trawls. Indeed the most successful nets contained more than 500 fish, squid, and shrimp, with numerous large specimens, in very good condition, and sometimes alive (Fig. 3.9). On Thursday, June 27th, and Saturday night three landers were deployed for 12 hours at the base, and the top of the Afanasy Nikitin Seamount in order to study the effects of depth/pressure on the fish and amphipod communities. The weather remained variable also this week with a mixture of clouds, sun, and partly heavy rain showers.

On Monday, July 31st, in the evening SONNE headed towards a thus far largely unexplored area ~300 nm southeast off Sri Lanka. Bathymetric maps based on satellite altimetry reveal a NE-SW-striking chain of seamounts and ridges, which are referred to as Buried Hills. The Buried Hills are important for us because they are most likely the only part of the 85°E Ridge north of the equator which is not covered by sediments of the Bengal Fan (even though their name implies the opposite). Before we reached the Buried Hills, we carried out one dredge at S-shaped, E-W-trending ridge. This feature is located on the "85° Fracture Zone" which we have already sampled ~2,000 km further south on our journey. The S-shape of the ridge is probably caused by tectonic movements at the "85° Fracture Zone". A dredge haul at this feature turned out to be one of the best of the cruise. The dredge returned olivine-feldspar-phyric and biotite(!)-pyroxene-feldspar-phyric lava as well as large amounts of volcanic glass. On Wednesday

morning we finally arrived at the Buried Hills. Unfortunately deep sea cables hindered us to sample the south-westernmost seamount of this chain. However, a dredge haul at a seamount located slightly further northeast yielded olivine-phyric lava fragments. The following five dredges were conducted at an S-shaped SW-NE-trending ridge (Fig. 3.10). Four of them recovered aphyric lava fragments. The last dredge of the journey aimed at a seamount located ~40 km east of the ridge but unfortunately returned empty. Besides extensive multi-beam mapping and sediment echo-sounder profiling, a total of 39 dredge hauls in an average water depth of 4,150 m were carried out on SO258 leg 1. Of these, 32 (= 82%) delivered *in situ* samples of which 29 obtained volcanic rocks, 15 volcaniclastics, and five sedimentary rocks. No equipment was lost or seriously damaged.

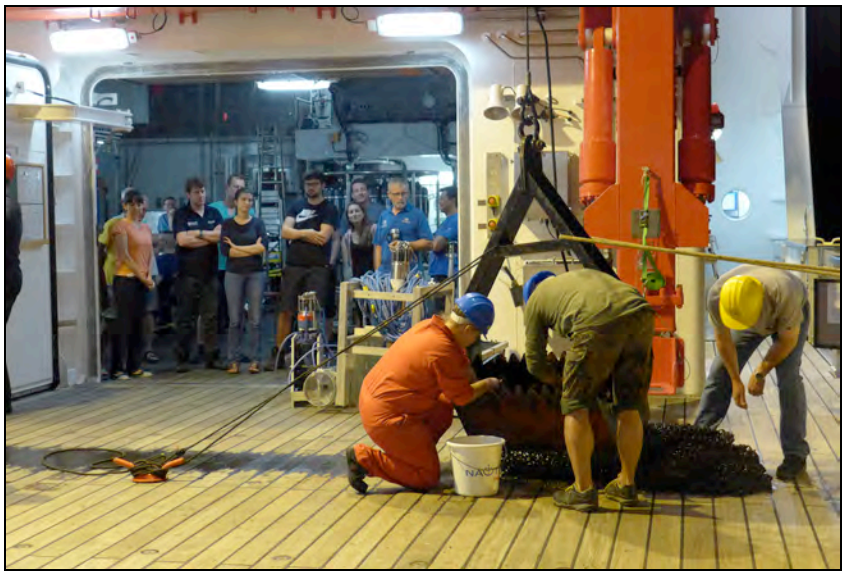


Fig. 3.10: A large audience wonders "what is in the dredge?" while scientists change the sediment traps, which are installed in the dredge. (Photo: Nora Krebs)

Fig. 3.11: A young whale shark visits the SONNE. (Photo: Ulrich Mattheus)

The last Tucker Trawl was carried out on Tuesday, July 4th, during transit to the Buried Hills. As before the net contained a high number of specimens allowing the successful completion of ongoing experiments. In the remaining days of the cruise current experiments (circadian rhythms, electrophysiology, visual pigment regeneration) were completed. In summary, the catches during the cruise SO258 leg 1 were much better than we had hoped. In total, the number of specimens by far exceeded 2,000. Over 150 species of fish from 81 genera and 38 families were caught. These were typical of the mesopelagic assemblage but included interesting abundancies and exclusions. For example, only 3 juvenile *Anoplogaster* were caught and no *Diretmus sp*, while many *Stylephorous* (11) were caught along with stomiiforms from at least 22 genera including hundreds of hatchetfish (Stenoptyx and Argyropelecus), viperfish (Chauliodus), bristlemouth (Gonostoma) and the rare *Malacosteus niger* or *australis* (22 individuals) and *Eustomias* sp (28 Individuals). The diversity of cephalopods, too, was unexpectedly large with 33 cephalopod species (225 specimens from 17 Families and 27 Genera) brought on board. Crustaceans included many decapod shrimp, hyperiid amphipods, ostracods and an assortment of other isopods and amphipods. The catch, like fish, was again in some ways typical of what was to be expected in mesopelagic trawls but with some gaps.

On Friday, July 7th, we left our working area and R/V SONNE headed towards Colombo. Among others, the transit was used for preliminary studies of the data and samples as well as for cleaning, maintenance, and packing of our equipment. On Saturday, July 9th, we finally reached the port of Colombo according to schedule at 08:00 am.

Figure 3.12 shows an overview of the sampling stations and the ship´s tracks of R/V SONNE cruise SO258 leg 1. For more detailed maps see chapter 7.

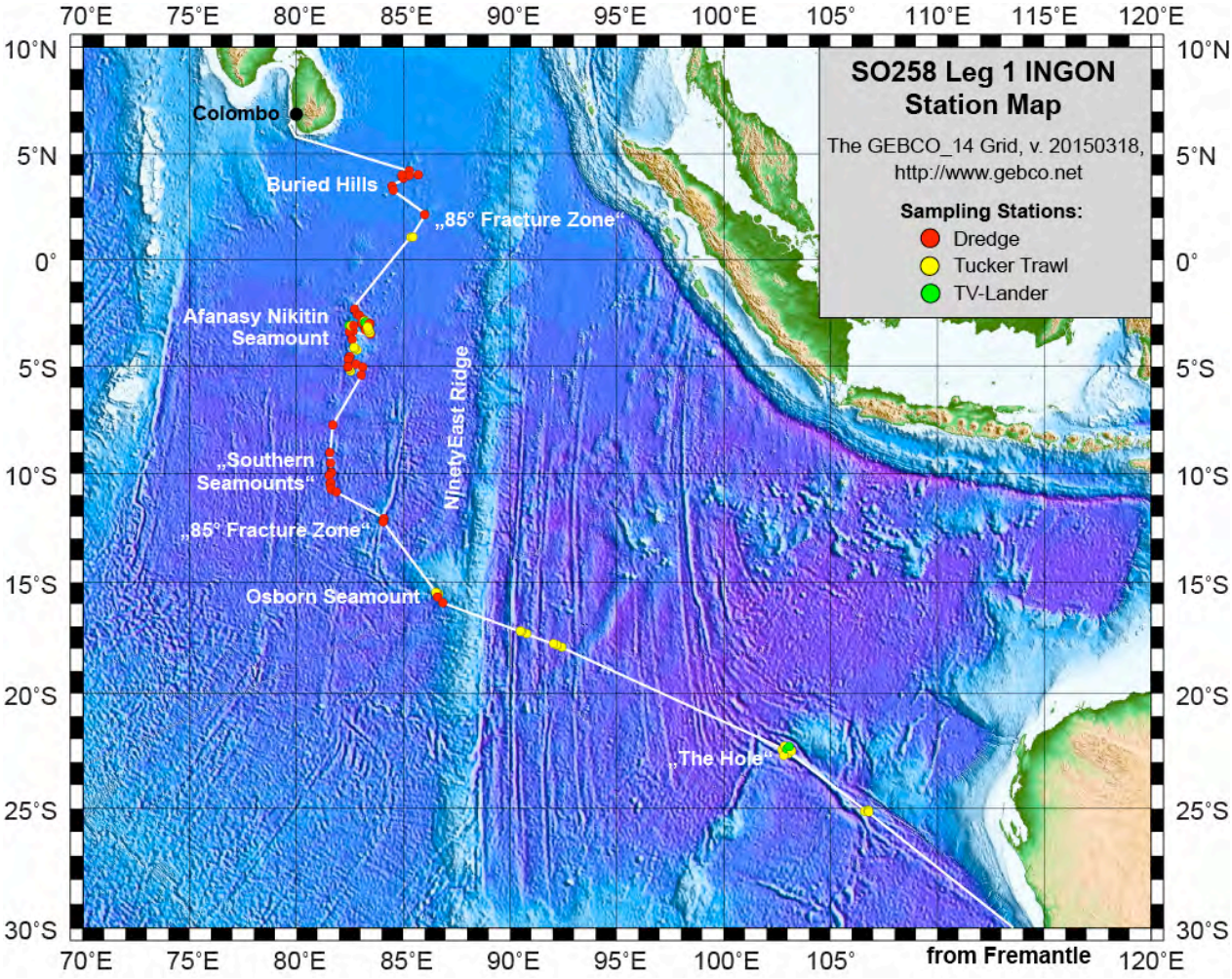


Fig. 3.12: Ship´s track and sampling stations (colored dots) of R/V SONNE cruise SO258 leg 1 (data base for bathymetry: The GEBCO_2014 Grid, version 20150318, http://www.gebco.net).

4. AIMS OF THE CRUISE

(J. Geldmacher, H.-J. Wagner, R. Werner, K. Hoernle)

4.1 PROFILING AND ROCK SAMPLING

R/V SONNE cruise SO258 leg 1 is part of the research project INGON, which is a collaboration between the Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI) and the GEOMAR Helmholtz Centre for Ocean Research Kiel. Using the example of the Indian-Antarctic Breakup in Late Cretaceous, SO258 INGON aims to investigate magmatic and tectonic processes that trigger the breakup of continents and the formation of ocean basins. This is not only an important topic in basic research contributing to a better understanding of the Earth system but also provides important data on the relations between magmatic and volcanic activity and their influence on environment, climate, and ecological systems. The main objective of the geological investigations of SO258 leg 1 is to put sound constraints on the evolution to the so-called 85°E Ridge in the central Indian Ocean between 82° and 86°E by sampling scarce outcrops of this ridge. In addition to the Afanasy Nikitin Complex (2° - 6°S), which has partly been investigated by Russian, Indian, and U.S.-scientists (e.g. Sushcheevskaya et al., 1996; Mahoney et al., 1996; Borisova et al., 2001, Krishna et al. 2014, see also chapter 6.2), the 85°E Ridge basement is exposed at two more locations: 1) the Buried Hills at 3° - 5°N and 2) the "Southern Seamounts" (working name given by the cruise participants) at 8° - 11°S. As evident from seismic reflection profiles (Krishna, 2003), volcanic structures are exposed at the Buried Hills. This location is also the northernmost site, where 85°E Ridge basement is not covered by Bengal Fan sediments and can be reached without drilling. No seismic or multi-beam data existed from the "Southern Seamounts" prior to SO258, but the predicted bathymetry reveals distinct volcanic (?) seamounts in that area. At both, the Buried Hills and the "Southern Seamounts", the flanks of the exposed structures appear to be steep enough to bear only thin or no sediment cover and are, therefore, promising for obtaining basement samples by dredging. Obtaining samples from both locations, 870 km to the north and approx. 450 km to the south of the Afanasy Nikitin Complex, are important to test for an age progression and track a possible geochemical evolution of the 85°E Ridge, particularly the EM 1 (Enriched Mantle 1) signal, through time. Data from the Rajmahal Traps, presumed to be the initial product of the Crozet plume (if a hotspot model is accepted for the 85°E Ridge), are inconclusive, because the Rajmahal lavas are erupted on continental crust and therefore may be affected by contamination through continental crust (e.g. Mahoney et al. 1996). On the other hand, if a hotspot model is accepted for the 85°E Ridge, published age dates of Rajmahal lavas could provide hints of time of the initiation of the Indian / Antartica break-up which is controversially discussed (e.g. ~136 or ≤116 Ma). Central questions to be addressed by the planned geochronological-geochemical (dredging) program for the 85°E Ridge are:

- What is the origin of the 85°E Ridge and what implication can be drawn for the regional kinematic reconstructions of the northern Indian Ocean: Does the 85°E Ridge represent an age-progressive hotspot track? Alternatively, was this structure formed by shallow (non-hotspot) processes, e.g. through upwelling of delaminated continental lithosphere at/near a mid-ocean spreading centre or possibly along N-S-oriented fracture zones cutting through the lithosphere? Could reactivation of these fracture zones, for example related to the subduction of the eastern Indian seafloor beneath Indonesia, have triggered local shallow decompression melting of upper mantle or have served as pathways for decompression melts formed through small-scale convection in the upper mantle to reach the surface?
- The sampling of the "Southern Seamounts" at 8° - 11°S and magnetic profiles between these seamounts and the Afanasy Nikitin Complex will allow us to directly test the hypothesis of a fast acceleration of India at around ~65 Ma (Cande and Stegman 2011). The age dating of the rocks along the at least 200 km long outcropping features provide the only direct data to support or reject the Indian motion model by Cande and Stegman (2011). The samples might provide new insights, if and how plumes can influence the motion of plates.
- In conjunction with the geochronological/petrological/geochemical program, a deep seismic sounding profile is planned by the AWI across the 85°E Ridge to determine its crustal thickness, helping to constrain if it had a magmatic origin. The location of the profile is in an

area not disturbed by large (and possible younger) seamount complexes like the Afanasy Nikitin Seamount.

In summary, there are a number of outstanding questions concerning the separation of India from Antarctica and the role that a mantle plume may have played in this break-up which should be addressed by SO258 leg 1: 1) When exactly did the breakup begin? 2) Could the 85°E Ridge represent the hotspot track (plume tail) related to the Rajmahal trap event (plume head)? 3) What is the origin of the end-member EM 1 component at Afanasy Nikitin? Why do these basaltic rocks have the most enriched isotopic compositions of all igneous rocks found in the ocean basins that are not directly associated with slivers of continental lithosphere? Integration of the results of SO258 leg 1 with those of geophysical investigations (seismic, magnetic, gravity) conducted by the AWI on SO258 leg 2 will help to answer these questions and substantially improve our understanding of geodynamic evolution of the Indian Ocean.

4.2 BIOLOGY: LIGHT CONDITIONS IN THE MIDWATER HABITAT AND THE PERCEPTION OF BIOLUMINESCENCE

In the deep-sea, sunlight plays only a minor role between 500 and 1,000 m of depth, and is no longer detectable below 1,000 m. Therefore, bioluminescence is the major source of light; it is found in numerous species inhabiting this mesopelagic habitat. Observations in the "wild" from submersibles, and from specimens recovered alive from catches, in the laboratory, have shown a remarkable diversity of spatial and temporal patterns of bioluminescence. Unfortunately, the biological significance of these often highly elaborate displays are largely a matter of speculation. The probable uses range from camouflage by counterillumination of the ventral side (hatchetfish), disturbance of predators by release of luminous clouds (see below); intraspecific signaling or identification of sexual mates; luminous lures (anglerfish); illumination of potential prey by "headlight photophores" (some lanternfishes). In general, the wavelengths emitted by the photophores match closely the colour of the downwelling sunlight at mesopelagic depths, i.e. the light produced is bluish-green (λmax about 480nm). In very few cases (which are of special interest during this cruise), however, stomiid dragonfish carry light organs emitting red light under their eyes, in addition to the ordinary bluish photophores elsewhere on their bodies.

Many specimens of the mesopelagic fauna show conspicuous and characteristic adaptions of their visual systems to bioluminescence. These are observed from the macroscopic to the molecular level and range from special eye designs like tubular eyes, yellow lenses, to multibank rod retinae and peculiarities of the visual pigments. Our aim was to carry out morphological, physiological, biochemical and molecular experiments during this cruise to obtain more details of these adaptive mechanisms.

While most of our work has focused on the visual system, other sensory systems also play a major role in the life style of the mesopelagic fauna. A quantitative estimate is provided by the volumetric analysis of brain sensory areas and the axon numbers in the cranial nerves. Thus a further aim was to collect brains and tissue for these analyses.

Finally, in a more heuristic approach to the deep-sea, and especially the hadal fauna, autonomous lander for the first time have explored the ecosystems around 6,000m of depth in various parts of the Indian Ocean.

4.2.1. Experiments carried out as planned

1. Pigment regeneration

Studies of the visual pigments in the outer segments of retinal photoreceptors have yielded a number of highly interesting observations. Bleaching of these visual pigments by photons triggers the stimulation cascade which ultimately leads to a visual perception. Visual pigments (rhodopsins) that have been bleached by high light intensities are regenerated in the pigment epithelium by a complex shuttle mechanism involving interphotoreceptor matrix. For morphological and physiological reasons the process of bleaching of visual pigments must be markedly different in eyes of terrestrial or surface-water animals whose retinae are characterised by a well-developed pigment epithelium. At 500 m depth light intensity is much reduced. Retinae typically contain multibank rod retinae which face a particular problem when it comes to visual pigment regeneration, because there is an obvious imbalance between the volume of outer segment material and the volume of pigment epithelial cells. Furthermore, pigment epithelial

cells are located at a considerable distance from the vitread rows of rods. Anecdotal observations in demersal and mesopelagic fish indicate that bleaching of visual pigment is substantially slower than in epipelagic species. It has been has argued that bleaching by bioluminescence was negligeable, and therefore the need for pigment regeneration doubted.

A combined series of morphological, electrophysiological and biochemical experiments are planned to study this question in more detail. The results could also show, whether submersibles equipped with high intensity flash lights are capable of inflicting permanent damage to the eyes of deep-sea animals.

2. Tubular eyes; variations in eye design

Since the early work of Brauer, peculiar outpocketings including all the ocular layers, called diverticula, have been observed in several species with tubular eyes. The functions of these diverticula have been enigmatic in spite of intense speculation until we discovered reflective material in the wall separating them from the tubular eyes which forms a functional, and even focussing mirror e.g. in the spookfish *Dolichopteryx longipes,* thus considerably increasing the visual field. More recently, it was realized that other species from the family Opisthoproctidae contain diverticula of varying degrees of complexity, which makes this particular family appear as an “evolutionary experiment”. Additional material is required to put this into a phylogenetic perspective by extending our morphological findings to a molecular level.

3. Brain and cranial nerve analysis

Lanternfish (myctophids) are one of the most abundant families of mesopelagic zone with about 250 species, and occupy all of the world’s oceans. They are bioluminescent and are part of the largest animal migration we know of, a diel vertical migration towards the surface at night in order to feed and a return to the depths (up to 1000 m) to avoid predation from surface dwellers. Recent investigations of their visual system showed major interspecific differences in the differentiation of their eyes and brains suggesting that some species might rely more on vision than others. The aim of this cruise is to catch additional species of lanternfish, and extend the quantification to include volumetric brain data and quantitative analyses of axon counts of cranial nerves to assess the impact of the individual sensory system on life style and behaviour.

In addition to lanternfish, this approach will be applied to other common mesopelagic fish species.

4. Transcriptome analysis in mesopelagic fish

All fish caught on this cruise will be identified, measured and preserved in toto in a mixture of ethanol and formaline to allow later molecular work if required. In addition, gills, fin clips and eyes from fresh material are to be collected and stored in RNAlater. This will enable us to carry out an analysis of the transcriptome in families of particular interest such as stomiids (visual pigments) and opisthoproctids (tube eye differentiation) and myctophids (see above).

5. Shrimp vision

Mesopelagic oplophorid shrimp, possess two visual pigments, one with a maximal sensitivity in the blue wavelengths, and the other with a maximal sensitivity in the near-UV (400-410 nm). The presence of this last pigment is surprising, as there is no UV light in that environment. However, the spew they produce as deterrent has a very broad spectral distribution and that of photophores is very narrow. Therefore it is possible that the broader spectral emission of the spew would be more efficient in stimulating the violet receptor, and could therefore be distinguished from the narrower bandwidth photophore emission. This hypothesis has not been tested any further, due to the lack of species that possess both spew and photophores and the current cruise provides a singular chance to finally test this idea.

6. Visual ecology of cephalopods

Cephalopods are textbook examples for convergent evolution of visual systems with respect to the vertebrate situation. This does not only apply to the general blueprint of the camera-type eye but also to midwater adaptations such as tubular eye design. However, compared to our knowledge about the visual system of mesopelagic teleosts in terms of structure, function and evolution, the visual system of these cephalopods is truly rudimentary. The plan for this cruise is to investigate eyes and brains of cephalopods on three different levels: visual pigments will be characterized on the molecular level and their absorbance characteristics determined by MSP. This will also shed some light on phylogenetic relationships. Next, labelling experiments will be

carried out to elucidate the connections between the retina and the optic lobes. Additional functional information will be gathered from electrophysiological ERG experiments.

7. Investigation of the hadal fauna of the Indian Ocean

The hadal zone represents a distinct cluster of ultra-deep yet geographically and bathymetrically isolated ecosystems, situated mostly around the Pacific Rim. The trenches are deep subducting zones and despite the extreme hydrostatic pressure, low temperatures and limited food supply, are known to host a diverse and often locally endemic assemblages of species. The hadal zone is typically categorized by being deeper than 6,000m, however, there is growing evidence to suggest that depth *per se* is not necessarily the only driver of community structure at such extreme depth. Topographic variability appears to be as important as depth in many instances and therefore the hadal zone can be split into three main habitat categories: the subduction trenches, trench faults and troughs, albeit all must be deeper than 6,000m.

Data from previous cruises on R/V SONNE and other vessels have highlighted various trends in biodiversity and community structure across the abyssal-hadal transition zone at inter- and intra-trench levels. However, these have emerged in the analysis of communities spread over large bathymetric ranges in the vicinity of a deep subduction trenches and do not necessarily address the question of whether quintessentially 'hadal' fauna is a product of depth or trench topography. The current cruise provides an ideal opportunity to test just this. Our hypothesis is that the Western Australian Basin communities are simply deep abyssal communities and that the true hadal zone belongs to the deep subduction trenches and can therefore not be categorized by depth alone.

4.2.2. New and additional experiments

Due to unforeseen dropouts or cancellations in the scientific party, alternative experiments were planned with the aim of completing projects that were begun at previous R/V SONNE cruises.

1. Fish hearing

After previous work on the structures of the sensory epithelia in the vestibular utricle and saccule of the inner ear in a variety of deep-sea fish we had the opportunity on this cruise to carry out physiological tests in order to characterize the actual function of mesopelagic fish ears. Using a purpose-built test chamber we set out to study the frequency-dependent sensitivity of the hearing apparatus in a variety of mesopelagic species and compare the results to surface-living fish as controls.

2. Clock genes

Many textbooks maintain that inhabitants of caves and the deep-sea are the only living things lacking endogenous circadian clocks because they are not exposed to the solar cycle. However, this is only partly true for the mesopelagic fauna, because downwelling residual sunlight is important for their vision (see above: tubular eyes), and is also thought to be involved in the control of their diel vertical migrations. Our aim on this cruise is to examine clock function at the cell and molecular level in fish species that live mostly in deep ocean environments and which undergo vertical migration. Do they still possess a functional circadian pacemaker? How is this clock set? Does it use light in the standard manner of most organisms? What does the clock control in these animals? How are rhythms in processes such as DNA repair regulated? Experiments on this cruise with focus on mesopelagic species, but a future goal will be to compare these rhythms with those found in deeper, benthic or hadal species.

3. Visual pigments in red sensitive stomiid fishes

The three species of stomiid fishes that carry red-light emitting photophores (*Malacosteus niger, Aristostomias tittmanni* and *Pachystomias microdon*) are also capable of seeing long-wave light, unlike almost all other mesopelagic fishes (see above). While *Malacosteus* uses a diet-derived photosensitiser to broaden the spectral sensitivity of its eyes, the two other species are thought to contain long-wavelength-sensitive opsins. However, this issue is controversial and requires further molecular work. Unexpectedly, in the area of the Afanasy-Nikitin Seamount we found a number of these rare stomiids in our trawls and therefore plan a new approach using the more sensitive transcriptomics technique to settle the dispute.

5. AGENDA OF THE CRUISE

(R. Werner, J. Geldmacher, H.-J. Wagner)

To achieve the scientific goals of cruise SO258 leg 1 should conduct systematic multi-beam mapping, sediment echo-sounding, hardrock sampling by dredging, biological sampling by Tucker Trawl and lander equipped with traps, as well as documentation of hadal fauna using camera lander. The planned geological and biological working areas are shown in figure 5.1, additional trawling was planned on the transit to area A and between the working areas.

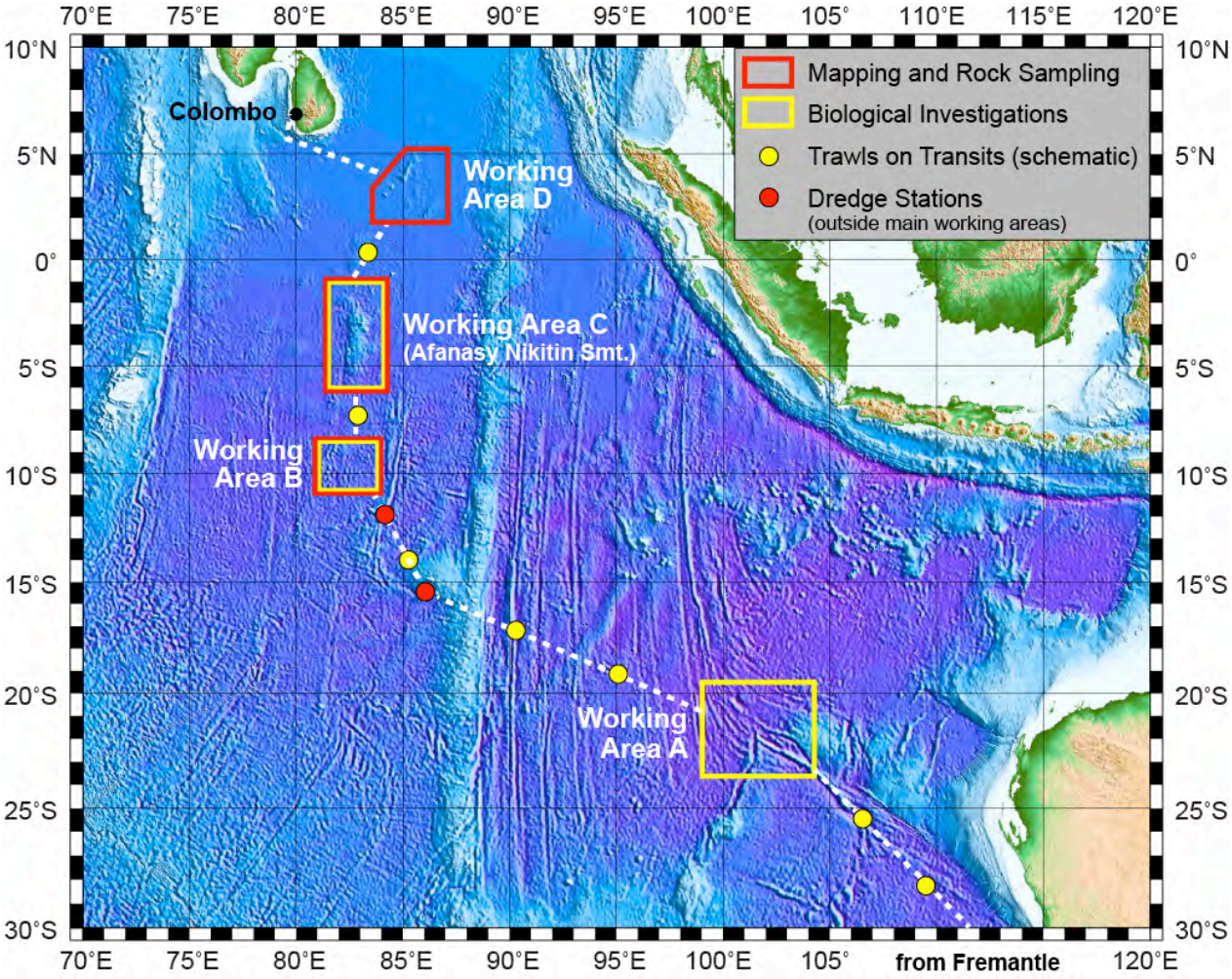


Fig. 5.1: Overview map based satellite altimetry (The GEBCO_2014 Grid, version 20150318, http://www.gebco.net) showing the planned ship´s track and the geological and biological working areas of cruise SO258 leg 1.

5.1. GEOLOGICAL INVESTIGATIONS

The major targets of dredging and related profiling were all accessible volcanic structures along the so-called 85°-Ridge (Fig. 5.2):

Area B (8°S - 11°S; "Southern Seamounts"): These completely unexplored seamounts and ridges south of the Afanasy Nikitin Complex most likely represent the southernmost outcrops of the 85°E Ridge. In order to extend testing for an age progression south of the Afanasy Nikitin Complex, samples from these features are crucial.

Area C (2°S - 6°S; Afanasy Nikitin Complex): A cluster of individual cones and elongated peaks rest on the Afanasy Nikitin Ridge. They have steep flanks free of sedimentary cover. The majority of these peaks are located in the north and the south of the Afanasy Nikitin Complex, with a few in between having little relief. The largest peak, the Afanasy Nikitin Seamount, reaching 1,549 m b.s.l. (below sea level), and a restricted area at the western flank of the basal

Afanasy Nikitin Ridge are the only sites, which have been sampled thus far. Therefore, particular emphasis of hard rock sampling lay on seamounts that were not previously sampled, such as the prominent SW-NE elongated structure at 2°40'S, the prominent cone at 3°20´S or the highest cone in the southern part of the Afanasy Nikitin Ridge at 4°10'S. Concerning the Afanasy Nikitin basement, dredging focused on the western, northern and eastern sites, which have not been sampled by previous cruises.

Area D (3°N – 5°N; Buried Hills): The Buried Hills comprise an elongated chain of seamounts and ridges which represent the northernmost accessible part of the 85°E Ridge. As evident from seismic reflection profiles (Krishna, 2003), volcanic structures are exposed in that area. Line 98791 of Krishna (2003) shows that the flanks of the exposed structures are steep enough to bear only thin or no sediment cover and are therefore promising for obtaining basement samples by dredging.

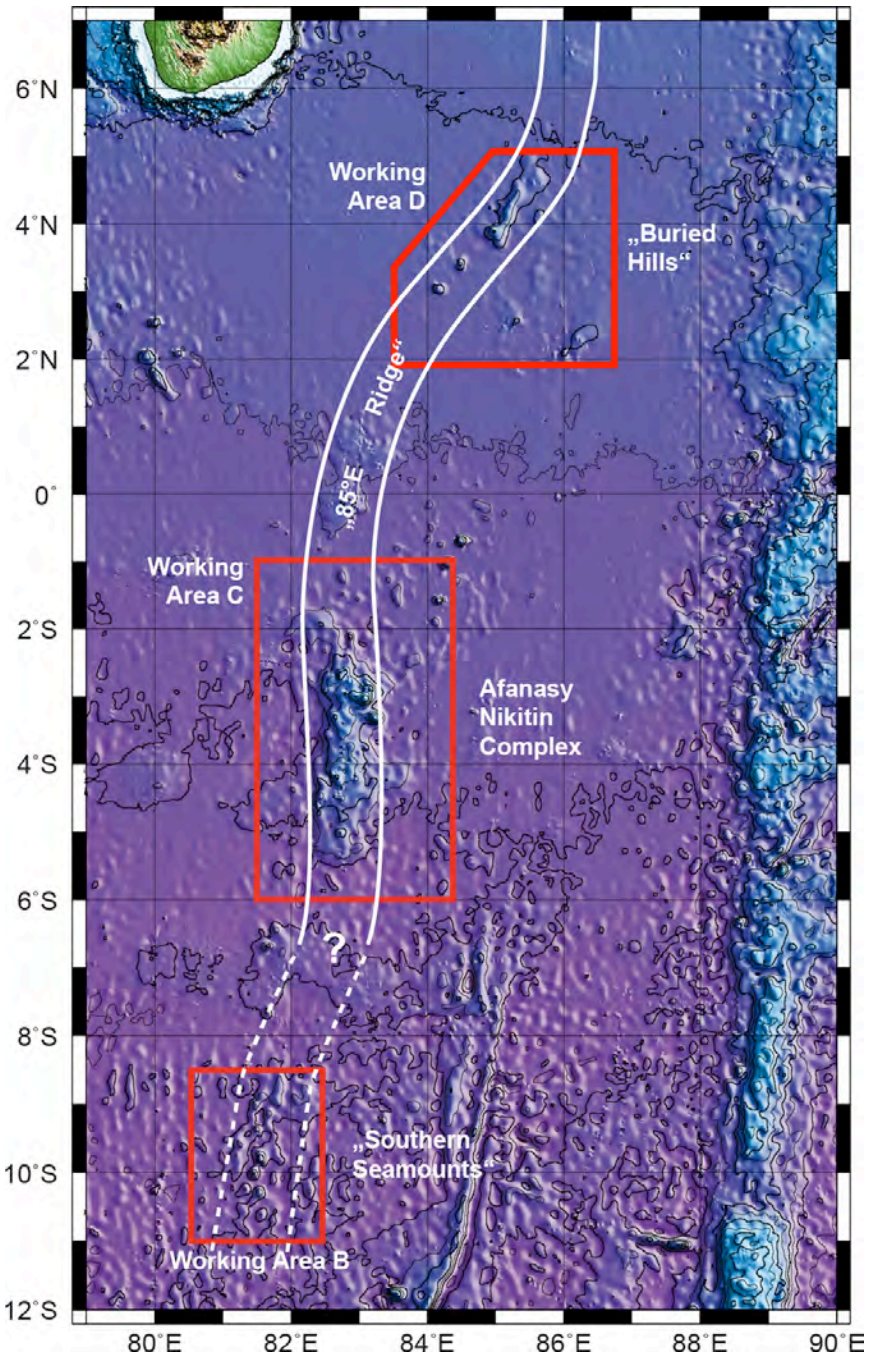


Fig. 5.2: The 85°E Ridge in the central Indian Ocean with the main working areas for dredging and related profiling.

The working areas discussed above have been selected based on the available multi-beam data and data sets such as Etopo (Smith and Sandwell, 1997) and GEBCO

(http://www.gebco.net). The selection of single dredge tracks, however, crucially depended on detailed multi-beam profiling conducted during the cruise. Additional factors influencing station selection were the quality of the material obtained through earlier dredge hauls in the area and of course sea conditions. Therefore the exact localities of the dredge sites had to be chosen during the cruise. Extensive multi-beam mapping was also conducted to identify different geomorphological units and structures, and stages of volcanic activity.

5.2. BIOLOGICAL INVESTIGATIONS

After assembly of the rectangular midwater trawl (RMT45) the first nets should be deployed on the transit to working area A, and outside the Australian EEZ (Exclusive Economic Zone) in order to test the control of the opening and closing mechanisms (Fig. 5.1).

The first working area (area A in Fig. 5.1) is located in the Western Australian basin, a complex deep structure reaching, according to available data prior to multi-beam bathymetry on this cruise, 6,200 and 7,470m of depth in two areas (22°S by 110°E). By deploying the lander systems outlined below, biodiversity and community structure should be investigated in the deep hadal area at 6,500m, and the slope leading to the surrounding abyssal plains at 4,700m depth.

On the transit to the working area B, several trawls were planned and, with the specimens obtained, we should be able to start the biochemical and physiological experiments.

In the area of the Afanasy Nitikin Complex, the complex seafloor topography leads to upwelling currents that improve the supply of nutrients for the macrofauna and raise the chances for rich and interesting catches. Accordingly at least 10 trawls and possibly further lander deployments should be conducted in working area C. The lander should be deployed for 12 h each at the base and the top of the highest seamount of the Afanasy Nikitin area (i.e. Afanasy Nikitin Seamount) in order to study the effects of depth/pressure on the fish and amphipod communities. Finally trawls should be conducted just north of the equator on the transit to working area D.

A summary of the location, duration and depth of all trawls and lander deployments of the biological investigations is given in the Appendix I.

6. BRIEF INTRODUCTION INTO THE WORKING AREA

(J. Geldmacher, W. Jokat, R. Werner, H.-J. Wagner, K. Hoernle)

6.1 THE GONDWANA BREAK-UP AND THE DISPERSAL OF INDIA / SRI LANKA

During the Mesozoic, the Gondwana supercontinent covered the southern hemisphere. Gondwana consisted of today's southern continents/fragments: South America, Africa, Australia, Antarctica, India, Madagascar, and New Zealand. The break-up of Gondwana began with the separation of South America and Africa from Antarctica through northward drift. Constraints on the timing and geometry of the dispersal of the aforementioned continents are today well constrained by conjugate geophysical studies off South America and East Africa (Leinweber and Jokat, 2012). After a 50-80 m.y. pause, the dispersal of Gondwana continued with the separation of India/Sri Lanka/Madagascar and Australia from Antarctica. Finally, some 100 m.y. after the first rifting event within Gondwana, New Zealand drifted away from Antarctica (e.g. Larter et al. 2002; Hoernle et al., 2010). Even today this rifting process continues between West and East Antarctica indicated by active surface and sub-glacial rift-related volcanoes in West Antarctica/Ross Sea. Such long continental rifting phases are only observed for the dispersal of Gondwana. Furthermore, the rifting was accompanied by volcanic activity of variable strength, both on- and offshore, generally believed to have been related to the break-up of the supercontinent.

In the Gondwana break-up scenarios, the dispersal of India/Sri Lanka (INDSRI), which formed at that time a single plate, plays a unique role in the present day geodynamic models for the southern ocean, due to its very high drift speed (18-20 cm/yr; Gaina et al., 2007; Cande and Stegmann, 2011) after breakup compared to other Gondwana fragments (e.g., Africa ~4 cm/yr; Jokat et al. 2003). In addition, several interpretations place the appearance of onshore volcanism significantly later than the formation of oceanic crust offshore INDSRI, in contrast to models of the other southern continents where onshore volcanism precedes ocean crust formation. After break-up, during the northward drift of INDSRI, two well-defined hotspot tracks were formed. The Reunion hotspot track extends from the Deccan Traps flood basalt event (~68-62 Ma, e.g. see Cande and Stegmann, 2011) in western central India almost due south along the Seychelles to the Northwest Indian Ridge and then continues on the other side of the ridge to the active volcanoes of Reunion. In the east the Ninetyeast Ridge forms a very prominent hotspot track associated with the Kerguelen Plateau (flood basalt event) that initiated at ~118 Myr. Seismic measurements, indicating crustal thicknesses (24 km) and velocities (>7 km/s) typical for submarine plateaus formed above hotspots (Grevemeyer et al., 2001) support the interpretation of an entirely magmatic formation of the Ninetyeast Ridge. Marine magnetic data, in conjunction with rock age dates from DSDP/ODP (Deep Sea Drilling Program / Ocean Drilling Program) drill holes, provide a reasonable age model for the seafloor spreading in this region with ages decreasing systematically from 85 Ma at site 217 in the north to 61 Ma at site 215 in the south. In between another ridge-like structure, generally referred to as the 85°E Ridge (Fig. 5.2), formed just south of the Rajmahal traps during the Cretaceous. Because of the unclear relationship of the separation of India and the timing of Rajmahal trap volcanism (20 Ma after the onset of ocean spreading), the nature and origin of the 85°E Ridge could play a key role in understanding the breakup history of India.

6.2 THE 85°E RIDGE

The 85°E Ridge is one of three prominent basement ridges in the Indian Ocean. This ridge trends almost N-S except for a westward bend between 6 and 2 °N (Fig. 5.2). In contrast to the Reunion and Ninetyeast hotspot tracks, little is known about the 85°E Ridge. It is completely covered by thick sediments close to the East Indian coast, and thus not sampled at its northern end. Only south of Sri Lanka a number of seamounts (e.g. Buried Hills) and the well-exposed Afanasy Nikitin Complex allow direct probing of the 85°E Ridge. Age dating and geochemical analysis of rocks from of the ridge will provide sound constraints on the kinematic and magmatic history of this part of the Indian Ocean. E.g., if it can be demonstrated that the ridge represents an age progressive hotspot track initiating at the Rajmahal traps (forming the classical flood basalt-hotspot track succession), then the Rajmahal traps could represent the initial stage of the plume and could have, together with the Kerguelen plume, contributed to the initiation of the

separation of India from Antarctica. The implication, as also supported by the magnetic data off the coast of Antarctica, would be that the break-up is likely to have occurred after the flood basalt volcanism and thus at ≤116 Myr ago, rather than before it at 136 Myr ago. If the 85°E Ridge is indeed a hotspot track, then age determination of volcanic samples taken along the track could provide direct data for the absolute plate motion of the Indian Plate (assuming a fixed hotspot), which can be used to independently test the plate velocity models obtained from the planned magnetic investigations and to develop a comprehensive model for the drift of the Indian continent. We note that the Ninetyeast Ridge and Reunion hotspot track can only constrain the younger plate motion history (<85 Myr).

Unfortunately, the 85°E Ridge is today almost completely buried by the sediments of the Bengal Fan with only a few exceptions. It can, however, be traced by free air gravity and seismic reflection data. In contrast to the Ninetyeast Ridge, the 85°E Ridge was never sampled by scientific drilling. Direct sampling by other means (e.g. dredging) is limited to areas, where the general thick sedimentary cover is absent and basement is exposed at the seafloor. One of these rare sites, are a number of seamount south of Sri Lanka between 3° and 5° N, the so-called Buried Hills where seismic data indicate only sparse or even absence of sediment cover at steep seamount flanks where basement rocks can very likely be recovered by dredging. Another location, and the only location of the 85°E Ridge ever sampled, lies near the southern, youngest end of the 85°E Ridge between 1°45'S und 5°50'S, where the Afanasy Nikitin Ridge (Fig. 5.2) rises up to 3,800 m water depth (2,000 m above the adjacent abyssal plain). At the northern end of the ridge, the prominent Afanasy Nikitin Seamount (rising to depths of 1,549 m b.s.l.) is one of several cones resting on the Afanasy Nikitin Ridge. Alkali basaltic pillow-lava fragments were recovered from the shallowest peak of the Afanasy Nikitin Seamount in 1987 by dredging with the R.S.S. *Charles Darwin* and by dives with the Russian submersible *Mir* in 1990. In addition, the MIR recovered a suite of tholeiitic basalts (olivine-phyric and plagioclase-phyric) from the western flank of the main portion of the Afanasy Nikitin Riidge at a similar latitude. Based on the investigation of the samples (Sushcheevskaya et al., 1996; Mahoney et al., 1996; Borisova et al., 2001), it was proposed that the Afanasy Nikitin Complex is composed of a tholeiitic shield stage (forming the Afanasy Nikitin Ridge basement) and a subsequent alkali basaltic strato-volcanic stage (forming the peaks/cones on the Afanasy Nikitin Ridge and possibly other seamounts nearby). Microfossils in chalk associated with the recovered rocks give ages between 60 and 73 Ma providing a minimum age for the volcanic rocks, consistent with paleomagnetic age constraints of 75 to 90 Myr for Afanasy Nikitin Seamount formation (Krishna, 2003). More recently Krishna et al. (2014) have published $^{40}Ar/^{39}Ar$ dates for two basalt samples dredged by R/V AA SIDORENKO and RSS. CHARLES DARWIN, respectively, from the seamounts on the Afanasy Nikitin Ridge. The ages are consistent within error at 67 Ma. Based on these new ages, published geochronological data, new multi-beam bathymetric, and seismic reflection data together with previously described magnetic data Krishna et al. (2014) suggest that the Seamounts on the Afanasy Nikitin Ridge and the 85°E Ridge are unrelated as they were formed by different mantle sources, and that the proximity of the southern end of the 85°E Ridge to the Afanasy Nikitin Seamount is coincidental.

Currently, however, it is even unknown if the Afanasi Nikitin Ridge is genetically linked to the 85°E Ridge, since gravimetric and bathymetric data suggest that it was emplaced at or very close to a spreading center (Paul et al., 1990). According to Krishna (2003), the Afanasy Nikitin Ridge formed at a spreading ridge crest at ~85 Ma, while the hotspot that constructed the 85°E Ridge was still active in the northern Bay of Bengal. Volcanism at the Afanasy Nikitin Ridge was presumably later re-activated and the platform uplifted when the area drifted over the hotspot in Paleocene time. In contrast, Curray and Munasinghe (1991) propose that excess volcanism forming the Afanasy Nikitin Ridge was initiated when the 85°E Ridge-hotspot was situated near the spreading axis of the paleo-Southeast Indian Ridge and that the hotspot is currently located beneath the Crozet Islands (Curray and Munasinghe, 1991) or the Conrad Rise (Kent et al., 1997). The negative free-air gravity anomaly, measured along the 85°E Ridge, however, does not indicate the expected large (oceanic) crustal thickness as observed at the Ninetyeast Ridge (Krischna, 2003), placing a hotspot origin in question or indicating a very weak 85°E plume tail as compared to Kerguelen hotspot when it formed the Ninetyeast Ridge.

6.3 THE EM 1 MANTLE COMPONENT AT AFANASY NIKITIN

Another important aspect of the Afanasy Nikitin Complex lavas is their extreme geochemical and in particular isotopic composition. As most Indian Ocean MORB and intraplate volcanic rocks, both the Afanasy Nikitin Complex and the Rajmahal basalts posses an "enriched mantle" (EMI) composition, characterized by unradiogenic Nd, Hf and 206Pb/204Pb but radiogenic Sr isotope ratios. The Afanasy Nikitin basalt samples have the strongest affinity to the enigmatic global mantle end-member "EM 1" that is observed worldwide, in basaltic rocks erupted in an ocean basin, even more extreme than found at the Walvis Ridge in the Atlantic and Pitcairn Island in the Pacific. Among the postulated mantle end-members, EM 1 is the most enigmatic and its nature, origin and location within the mantle is intensely debated (see Geldmacher et al. 2008 for summary). The low Nd isotope ratios, however, point towards involvement of continental crust/lithosphere or rececyled continentally-derived sediments. A possible involvement of continental lithosphere in the magma source of Afanasy Nikitin and the rest of the 85°E Ridge has important implications for evaluating different models for the origin of the rise. The isotopic composition of the Rajmahal traps (neglecting the possible contamination of the ascending magmas with Indian continental crust) falls within the field for the Afanasy Nikitin Ridge samples, which generally have less enriched isotopic compositions than the Afanasy Nikitin Seamount lavas. A common observation with flood basalts is that they have less enriched compositions than much of the hotspot tracks, which are formed by lower degrees of melting than the flood basalts and therefore tend to preserve enriched components in the plume better. In addition to testing for an age progression, samples are needed from both north and south of Afanasy Nikitin to test if they have similar geochemical compositions to Afanasy Nikitin and the Rajmahal flood basalts.

Because of their distinct trace element and isotopic composition, Afanasy Nikitin Seamount alkali basalts are proposed to have formed by low degrees of melting of continental lithosphere (Mahoney et al., 1996; Borisowa et al., 2001). The lavas from the Afanasy Nikitin Ridge basement show a wider range in compositions. Although generally less enriched, they nevertheless indicate the involvement of a low Nd isotopic component, proposed to represent lower continental crust (Borissova et al., 2001). Therefore, relicts of Gondwana craton material (continental lithosphere and lower crust) may exist within or below the Afanasy Nikitin Seamount as confirmed for the Kerguelen Plateau (e.g. Ingle et al., 2002). If no age progression is found within the 85°E Ridge, Afanasy Nikitin and other parts, the presumed ridge may reflect shallow recycling of continental lithosphere, delamination during continental rifting or during drift of India through the upper mantle, as proposed for the New Zealand micro-continent (Hoernle et al., 2006), and subsequent upwelling of continental fragments beneath a spreading center. Such a model was recently proposed for the origin of the Christmas Island seamounts in the eastern Indian Ocean (Hoernle et al., 2011). Alternatively, if evidence is found that the 85°E Ridge is a hotspot track, a possible explanation as to why the Afanasy Nikitin Seamount basalts have the most extreme EM 1 type compositions found in hotspot basalts in the ocean basins is that these basalts were derived through very low-degrees of partial melting from a very weak plume, which could also explain why the hotspot track is much less prominent than the Ninetyeast Ridge formed by high degrees of melting.

6.4 BIOLOGY

Tucker Trawl deployments were carried out mainly within in geological working areas and on transits between these areas because *in situ* studies of mesopelagic and demersal fauna in this part of the Indian Ocean have not previously been performed. Additional stations were planned for the West Australian Basin on the transit to the geological working areas. Near the Australian continent, the western boundary of the Leuuwin current presents a nutrient-rich cold-warm water boundary with high productivity and therefore potentially good catches. However, trawls were also timed to make best use of ship time. Consequently they alternated with lander and geological activities and thus reduced strain on the crew as well as on the various scientist groups. The position of the lander deployments was more critical. Area A in figure 5.1 has been selected as main area for lander deployments because the predicted bathymetry and echo-sounding data reveal a ~6.500 m deep depression in that area which allowed us to compare the

hadal fauna in such a non-subduction related depression with those communities living in the circum-Pacific trenches. Lander work in the Afanasy Nikitin Seamount region allowed an additional and interesting approach to the study of depth on the hadal or demersal fauna composition by comparing sites at the base with those at the top of a guyot.

7. METHODS AND DESCRIPTION OF STATIONS

7.1 PROFILING AND ROCK SAMPLING

7.1.1 Methods

(R. Werner, F. Hauff, W. Borchert)

7.1.1.1 Bathymetry (Kongsberg Maritime EM122)

Data Acquisition

R/V SONNE is equipped with Kongsberg Maritime EM122 multi-beam echo sounder systems for continuous mapping of the seafloor. The systems consist of several units. A transmitter/receiver transducer array is fixed in a mills cross below the keel of the vessel. A preamplifier unit contains the preamplifiers for the received signals. The transceiver unit contains the transmitter, receiver electronics, and processors for beam-forming and control of all parameters with respect to gain, ping rate and transmit angles. The system has serial interfaces for vessel motion sensors, such as roll, pitch and heave, external clock and vessel position. The system also include high performance PC workstations. The operator software is the Seafloor Information System (SIS) running under Windows XP or Win7, which processes the collected data, applying corrections, displays the results and logs the data to internal or external disks.

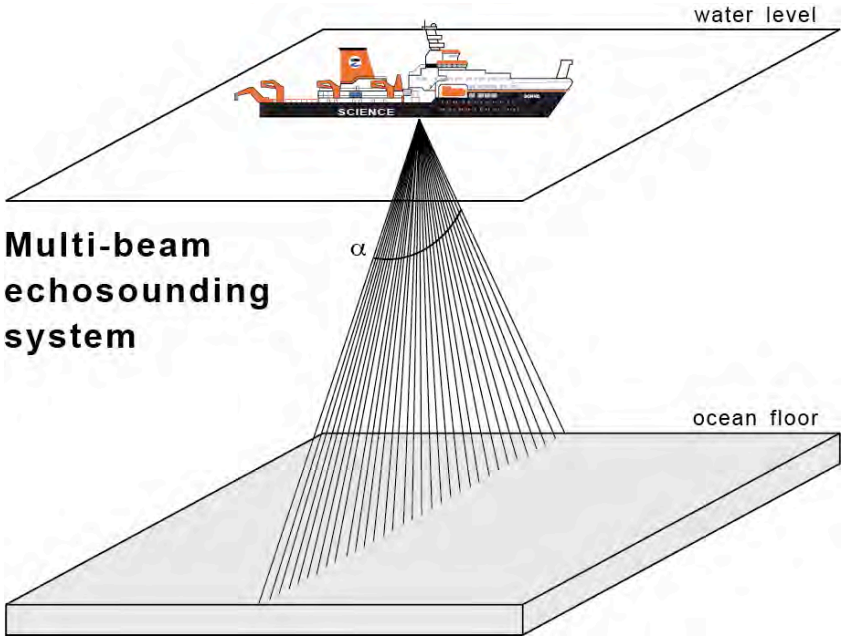


Fig. 7.1: Schematic sketch illustrating the principle mode of operation of multi-beam echo-sounding systems. The whole angular coverage sector (α) of the Kongsberg EM 122 system amounts is up to 150°.

The EM122 system uses a frequency of about 12 KHz with a whole angular coverage sector of up to 150° (75° per port-/starboard side, Fig 7.1). The depth range amounts to 20 - 11,000 m. The system has up to 288 beams and 432 soundings, respectively, per swath with pointing angles automatically adjusted according to achievable coverage or operator defined limits. The ping-rate depends on the water depth and the runtime of the signal through the water column. The variation of angular coverage sector and beam pointing angles was set automatically. This optimizes the number of usable beams. During a survey the transmitter fan is split into individual sectors with independent active steering according to vessel roll, pitch and yaw. This forces all soundings on a line perpendicular to the survey line and enables a continuous sampling with a complete coverage. Pitch and yaw movements within ±10 degrees and roll movements within ±15 degrees are automatically compensated by the software. Thus, the EM122 system can map the seafloor with a swath width about up to six times the water

depth (to approximately 30 km). The geometric resolution depends on the water depth and the used angular coverage sector and is less than 10 m at depths of 2,000 - 3,000 m.

The accuracy of the depth data obtained from the system is usually critically dependent upon weather conditions and the use of a correct sound velocity profile. During SO258 leg 1 two sound profiles has been determined using a CTD and a sound probe, respectively, ensuring the use of the correct sound velocity on this cruise. The CTD has been deployed at the southern tip of the "Southern Seamounts" before dredge operations started in that area and the second sound profile has been measured at the western edge of the Afanasy Nikitin Complex (see Appendix I). For mapping in the West Australian Basin, at the Osborn Seamount, and in the southern section of the 85° Fracture Zone, a sound velocity profile recorded on the previous cruise has been used.

Data Cleaning and Processing

The data cleaning procedure was accomplished by the QPS Qimera V. 1.4 software. After loading the raw data (.all files) from the EM122 and the correct sound velocity profile, a first filtering of failed beams has been conducted. Subsequently a dynamic surface has been created showing the ship´s track and the raw data (Fig. 7.2).

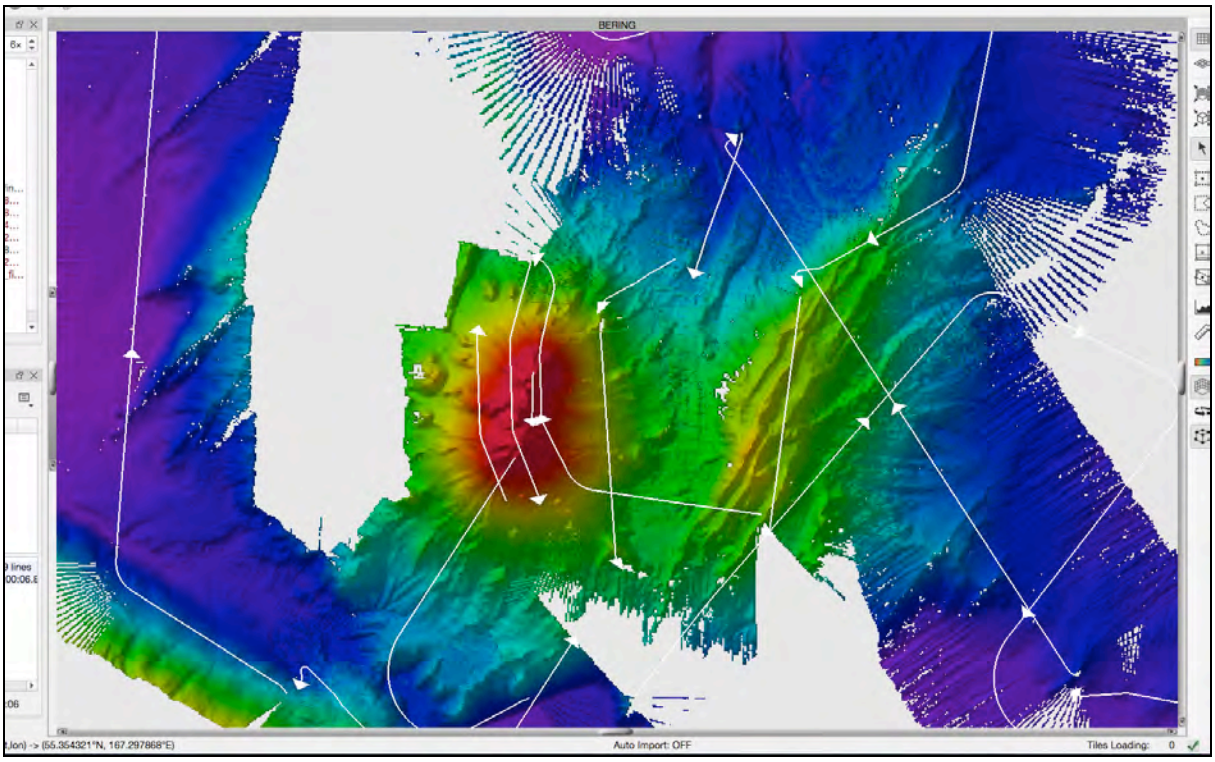


Fig. 7.2: Dynamic surface created with Qimera V 1.4 showing the raw data and the ship´s track.

Qimera allows an automatic elimination of major erratic data points using a spine filter. Furthermore there are several tools for detailed elimination of erratic data points, for example a swatch editor, a 2D editor or a 3D editor (Fig. 7.3) which all enable the operator to process each single beam stepwise. All editors display not only the cleaned data but also, if desired, the rejected data points and offer a variety of visualizations of the data (according to files, depth, intensity etc.). Additionally the data can be cleaned and edited using CUBE (Combined Uncertainty and Bathymetry Estimator, by University of New Hamshire).

After data cleaning a static surface has been generated from the dynamic surface, creating a .sd file which can be loaded in the QPS Fledermaus software, allowing 3D visualization of the cleaned data (see chapter 7.1.2). Furthermore the data can be exported in an ASCII x,y,z file format with header information for assembling, gridding and contouring with the GMT software (Wessel and Smith 1995). All this work was done by the system operators of R/V SONNE.

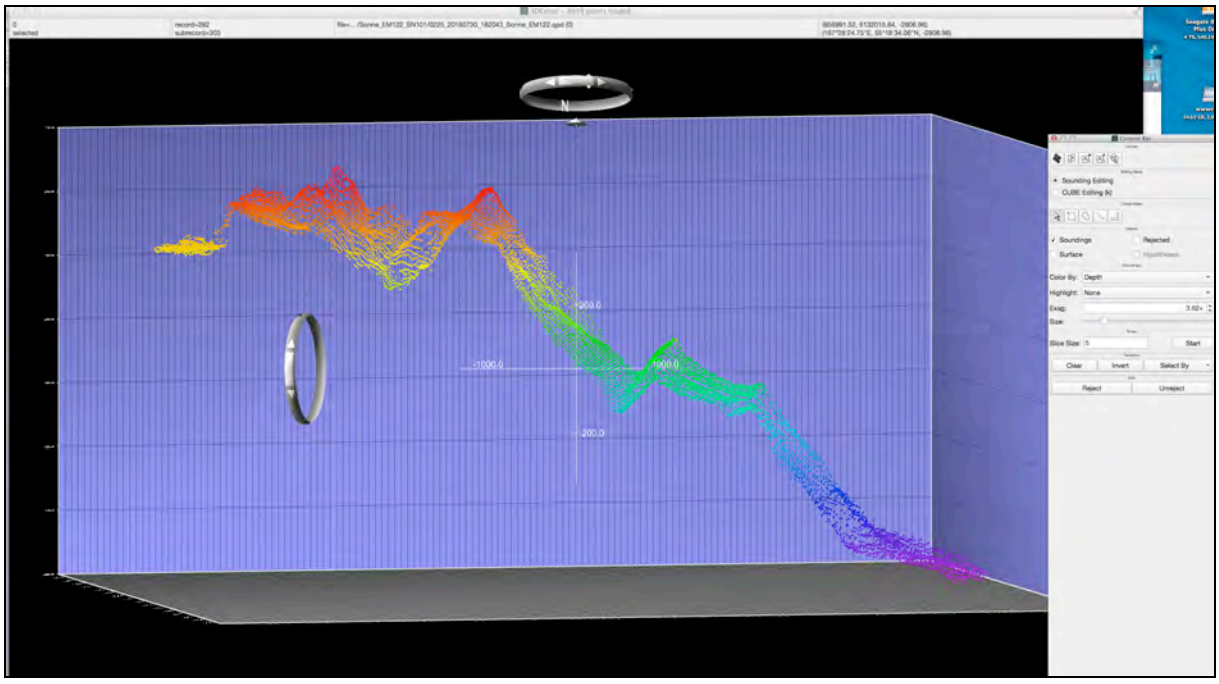


Fig. 7.3: 3D editor of Qimera V 1.4.

7.1.1.2 Sediment Echo-Sounding (Atlas PARASOUND P70)

Sub-bottom profilers (or sediment echo-sounding systems) are used to display sub-seafloor geological structures as, for example, marine sediment successions. The ATLAS PARASOUND sub-bottom profiler acts as a low-frequency sediment echo-sounder and as high-frequency narrow-beam sounder to determine the water depth. The sub-bottom profiler is based on the parametric effect, which is produced by additional frequencies through nonlinear acoustic interaction of finite amplitude waves. In principle, if two sound waves of similar frequencies (18 kHz and e.g. 22 kHz) are emitted simultaneously, a signal of the difference frequency (e.g. Secondary Low Frequency of 4 kHz) is generated for sufficiently high primary amplitudes. This new component is traveling within the emission cone of the original high frequency waves, which are limited to an angle of only 4.5° for the equipment used (Fig. 7.4). The resulting footprint size of only 7% of the water depth is much smaller than for conventional systems and both vertical and lateral resolution is significantly improved.

The ATLAS PARASOUND system is permanently installed on R/V SONNE. The hull-mounted transducer array has 128 elements within an area of 1 m^2. It requires up to 70 kW of electric power due to the low degree of efficiency of the parametric effect. The PARASOUND sub-bottom profiler on R/V SONNE is equipped with the digital data acquisition software from ATLAS Hydrographic, which is subdivided in ATLAS Parastore and ATLAS Hydromap Control. ATLAS Parastore allows the buffering, transfer and storage as well as the visualization of the digital echograms at very high repetition rates. ATLAS Hydromap Control is responsible for user defined modifications of the system (e.g. pulse rate or mode) and supports the operator in running the system properly.

PARASOUND data have been recorded during all SO258 leg 1 bathymetric surveys. During the cruise, however, only online profiles displayed on the screen have been used to identify tectonic features. The data acquisition included PHF and SLF data. All data have been copied on an external hard disk and sorted by the operator into folders according to data type (PHF, SLF / ASD, PS3, SEGY) and recording dates (0 to 24 hours UTC). The entire PARASOUND data set will be transferred to data co-operating specialists (working groups of Oleg Levchenko, IO RAS, and Wolfram Geissler, AWI) for further shore based processing and analyses and is archived in international data banks.

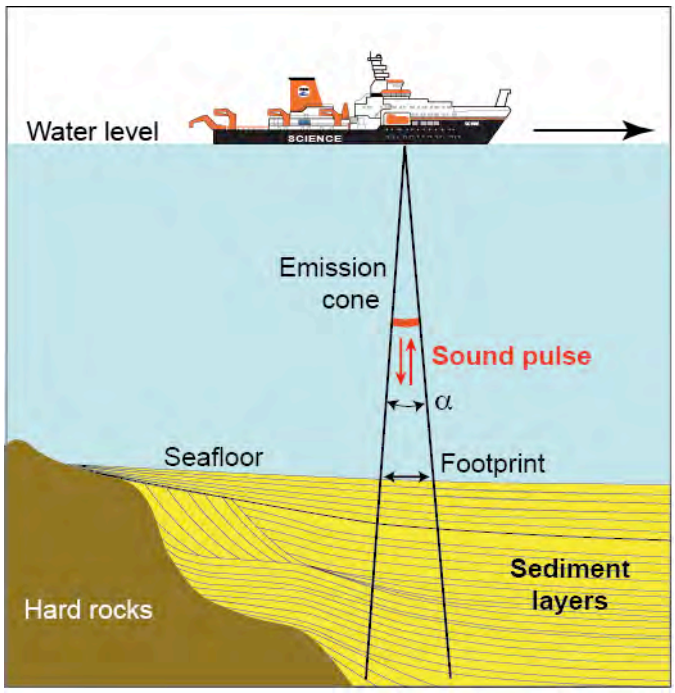


Fig. 7.4: Schematic sketch illustrating the principle mode of operation of sub-bottom profilers. The extremely narrowed beam of the ATLAS PARASOUND system of 4.5° (α) allows to resolve even small-scale bottom structures and offers a deeper penetration of up to ~200 m into the seafloor.

7.1.1.3 Dredging, Site Selection, and Laboratory Work

Rock sampling on SO258 leg 1 was carried out using rectangular chain bag dredges. Chain bag dredges are similar to large buckets with a chain bag attached to their bottom and steel teeth at their openings, which are dragged along the ocean floor by the ship´s winch.

General station areas were chosen on the basis of a number of existing datasets. These mainly include predicted bathymetry, derived from gravity data and ship depth soundings (etopo by Smith and Sandwell [1997] and "The GEBCO_2014 Grid, version 20150318", http://www.gebco.net), published data and maps, and profiles as well as unpublished data and information kindly provided by our colleague Oleg Levchenko (IO RAS).

The pre-selection of dredge stations at the Afanasy Nikitin Complex was mainly based on a new, unpublished multi-beam map kindly provided by Oleg Levchenko (IO RAS). These new data allowed us to sample more sites than originally planned because we could forbear from doing extensive bathymetric surveys before dredging in that area. Here, only the final positioning of the dredge tracks required multi-beam mapping by R/V SONNE. The selection of dredge sites at the almost completely unmapped other working areas, however, was critically dependent on detailed multi-beam echo-sounding surveys carried out at each site before dredging. Final positioning of the vessel over the dredge station was based on the bathymetric data including considerations of wind, swell and drift conditions. Dredge tracks were usually located - depending on the morphology of the structures - on steep slopes, at plateau edges, at scarps, canyon walls, fracture zones, and on the flanks of cones, ridges, and larger seamounts. This was mainly done to avoid areas of thick sediment cover.

Shipboard Procedure

Once onboard, all rocks collected with the dredge were first scanned for encrusting benthic invertebrates. Afterwards a selection of the rocks were cleaned and cut using a rock saw. They were then examined with a hand lens and microscope, and grouped according to their lithologies and degree of submarine weathering. The immediate aim was to determine whether material suitable for geochemistry and radiometric age dating had been recovered. Best suitable samples have an unweathered and unaltered groundmass, empty vesicles, glassy rims (ideally), and any phenocrysts that are fresh. If suitable samples were present, the ship moved to the next station. If they were not, then the importance of obtaining samples from the station was weighted against the available time.

Fresh blocks of representative samples were then cut for post-cruise thin section and microprobe preparation, geochemistry and further procedures to remove manganese and alteration products and/or to extract glass (if applicable). Each of these sub-samples, together with any remaining bulk sample, was described, labeled, and finally sealed in either plastic bags or bubble wrap for transportation to GEOMAR or cooperating institutions. Benthic invertebrates found on the dredged rocks were fixed on board in cold 100% ethanol and will be further processed and archived at the Museum für Naturkunde Berlin (MfN). Additionally bulk surface sediment was sampled at all stations from the sediment traps installed in the dredges being in particular relevant for meiofauna studies conducted by the MfN.

Shore Based Analyses

Magmatic rocks sampled by R/V SONNE from the ocean floor will be analyzed using a variety of different geochemical methods:

Ages will be determined by $^{40}Ar/^{39}Ar$ laser step-heating dating and U-Pb zircon dating. Major element geochemistry by X-ray fluorescence (XRF) and electron microprobe (EMP) will constrain magma chamber processes. Trace element data, obtained by inductively coupled plasma mass spectrometry (ICP-MS), will help to define the degree of mantle melting and help to characterize the chemical composition of the source. Phenocryst assemblages and compositions will be used to quantify magma evolution. Petrologic studies of the volcanic rocks will also help to constrain the conditions under which the melts formed. The composition of mafic basalts and basaltic glasses, as well as mafic melt inclusions, can be used to assess mantle temperatures at which melting took place, as well as pressures and degrees of melting. Sr, Nd, Hf and Pb (double spike) isotope ratios, determined by Thermal Ionization Mass Spectrometry (TIMS) and multi-collector ICP-MS, reflect the long-term evolution of the magma sources and thus serve as tracers to identify mantle and recycled crustal material. O-isotopes provide a powerful tool for evaluating the role of crustal material in the magma source. Morphological and volcanological studies will constrain eruption processes, eruption environment and evolution of the volcanoes.

Non-magmatic rocks and Mn-Fe oxides yielded by dredging can be transferred to co-operating specialists for further shore-based analyses.

7.1.2 Rock Sampling Report and Preliminary Results of Bathymetric Mapping

The following section gives background information and short summaries of the features sampled and/or mapped on SO258-1 and on the rock types obtained by dredging but also presents some preliminary interpretations of bathymetric data and rock assemblages. Distances, dimensions and heights given in this chapter are approximate and are only included to give a rough idea of dimensions of morphological features. Distances between seamounts are given between the seamount tops. All photos shown in this chapter are taken by GEOMAR. Refer to Appendix I and II for exact latitude, longitude, and depth of dredge sites and more detailed rock descriptions. Figure 3.12 shows a general overview map with all SO258 leg 1 sampling sites. Figures 7.5, 7.11, 7.17, and 7.21 show more detailed overview maps including station numbers for the working areas at Osborn Seamount and the southern section of the 85° Fracture Zone, the "Southern Seamounts, the Afanasy Nikitin Complex, and the Buried Hills (including the northern section of the 85° Fracture Zone). All overview maps are based on "The GEBCO_2014 Grid, version 20150318". Refer to Appendix III for detailed 3D-maps of all SO258 leg 1 dredge tracks, a few selected 3D maps are also shown in this chapter.

7.1.2.1 Osborn Seamount

The Osborn Seamount is a very large, positive bathymetric feature located immediately west of the Ninetyeast Ridge at 15°S. It rises from ca. 4,000 m below sea level (b.s.l.) to less than 2,000 m b.s.l. and has a base diameter of ca. 250 km (Fig. 7.5). While a hotspot track origin of the Ninetyeast Ridge is well established (Frey et al., 2015 and references therein), age and origin of the Osborn Seamount and possible genetic relations to the Ninetyeast Ridge are vastly unknown mainly due to the lack of basement samples from Osborn Seamount. Based on the predicted bathymetry, only the southern margin of Osborn Seamount seems to provide steep enough slopes where igneous basement might be exposed. SO258 leg 1 carried

out two dredges at stations DR22 and DR23 (Fig. 7.5). DR22 returned identical volcaniclastic rocks throughout. They consist of brownish clasts in a white matrix, which is probably ash (Fig 7.6). Some clasts have green palagonite cores. To a minimum the station provides evidence for a volcanic origin of the structure. It may be possible to obtain geochemical information by spot analysis if fresh glass is discovered. DR23 returned empty.

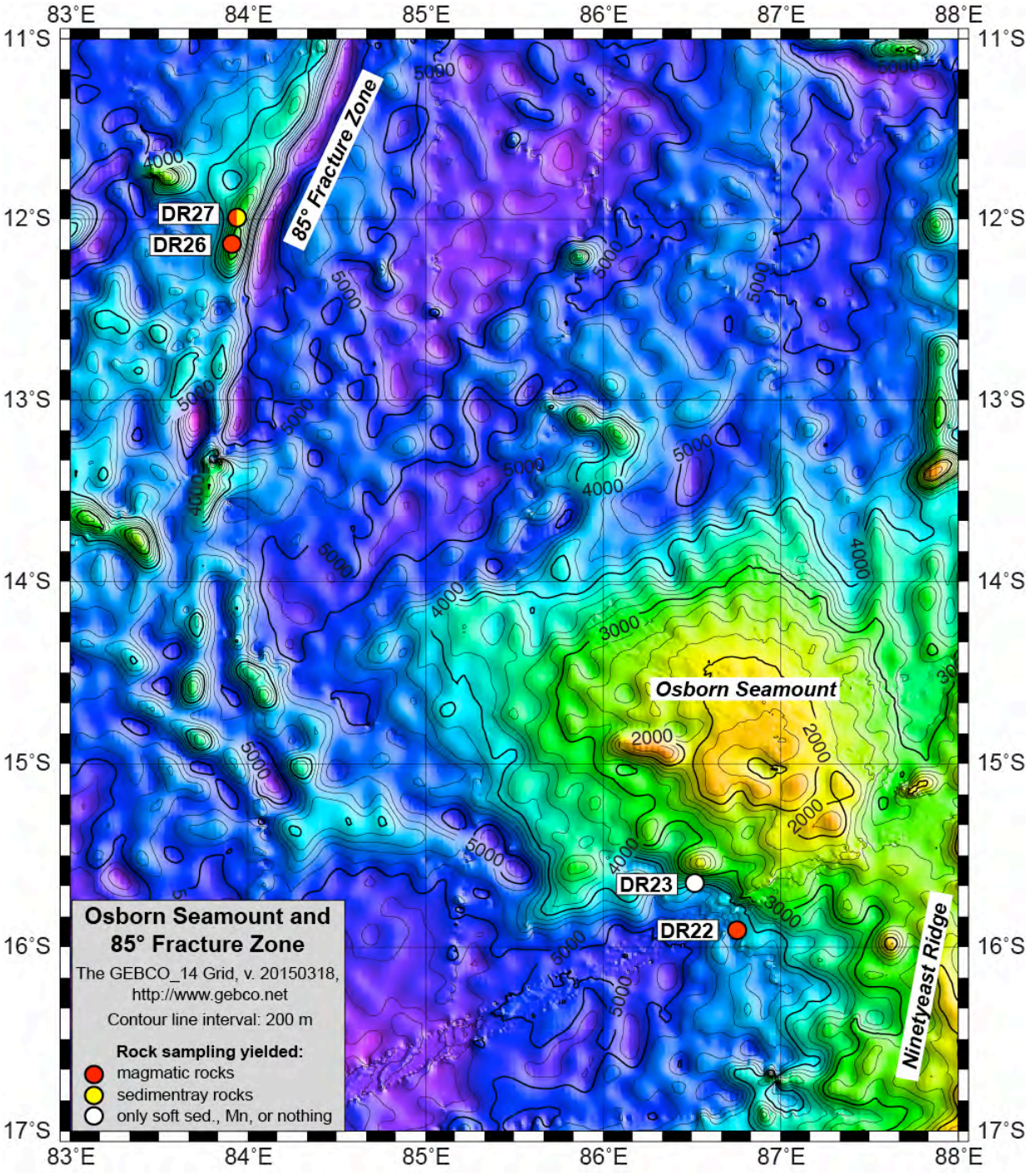


Fig. 7.5: Overview map showing Osborn Seamount and the southern section of the 85° Fracture Zone. Dots mark SO258 leg 1 sampling stations.

Fig 7.6: Volcaniclastic rock from Osborn Seamount with brownish clasts embedded in white matrix.

7.1.2.2 85° Fracture Zone

The NNE-striking 85° Fracture Zone (FZ) was sampled to obtain Late Cretaceous / Early Tertiary Indian Ocean crust uninfluenced by hotspot activity (e.g. Ninetyeast Ridge) or intraplate volcanism (e.g. "Southern Seamounts", Afanasy Nikitin). Furthermore age dating of igneous samples will provide ground truthing of ocean crust ages inferred by paleomagnetics. On maps based on predicted bathymetry, the 85° FZ is most prominently exposed between 6°S and 14°S while north of 5°S it becomes morphologically less expressed, reflecting increasing age of the ocean crust and thicker sediment cover as the Bengal Fan is approached. Two sampling attempts (DR26 and DR27) were carried out in the 13°S / 84°E area (Fig. 7.5) where the 85° FZ is marked by a prominent E facing scrap that displaces deeper / older (ca. 5,500 m b.s.l.) ocean floor in the east from shallower / younger (ca. 4,500 m b.s.l.) ocean floor to the west. Due to current and wind directions only the west-facing slopes of the FZ could be dredged. DR26 carried out at the base of the western slope (~4,000 - 3,550 m b.s.l.) returned several clasts of aphyric to slightly phyric Ol-Fsp basalts with slightly to moderately altered groundmass. A large breccia block contained, besides lava fragments, several clasts of pillow breccia that includes intra-pillow hyaloclastites that sometimes contain abundant fresh glass (Fig 7.7). The second location at DR27 also had to target the western flank of the 85° FZ at slightly greater depth (~4,120 - 3,740 m b.s.l.). It returned small fragments of aphyric to variably phyric Ol-Pl±Cpx basalts. The groundmass is in most cases moderately to strongly oxidized but slightly altered varieties also exist. Some pillow fragments have chilled margins with fresh glass. Notably two small fragments of Ol-gabbros (Fig 7.8) were also recovered indicating nearby exposure of deeper ocean crust. All igneous samples are typical for normal ocean crust.

Fig 7.7: Clasts from pillow breccia of the 85°E Fracture Zone at ca. 12°S. Note black areas of fresh glass.

Fig 7.8: altered Ol-gabbro from the 85° Fracture Zone at ca. 12°S.

A third location of the 85° FZ was sampled in the northernmost SO258 leg 1 work area at ca. 2°N / 86°E. Here the ocean floor is characterized by an east-west striking abyssal hill that has a characteristic S-shape in its center and displaces the eastern branch to the north. DR72 was carried out right in the center of the S-shaped bend which houses the only sufficiently

steep slope in the area. Surprisingly a suite (samples -1 to -16 + archive) of fairly fresh Biotite(!)-Cpx-Plg phyric, vesicular trachytes (?) along with glassy mini pillows ("glass eggs") were recovered (Fig 7.9 and 7.10). In addition a few moderately altered MORB like Ol-Plg to aphyric basalts (-17 to -21) were also found. While the latter are likely to represent regular ocean crust formed at a spreading ridge, the biotite bearing trachytes presumably result from low degree melting of a H_2O bearing source and transfer / eruption of these melts enhanced by tectonic pathways presumably in context with strike-slip faulting along the 85° FZ when it was a transform fault or later reactivation of the FZ by differential movements within the Indo-Australian plate.

Fig 7.9: fairly fresh piece of rare Bi-Cpx-Plg phyric trachyte (?) from the 85°E fracture zone at 2°10'N.

Fig 7.10. rounded glass fragment from hyaloclastite. Arrow points to fresh glass. Bio-Cpx and Plg are also embedded in glass.

7.1.2.3 "Southern Seamounts"

The "Southern Seamounts" refer to a series of north-south striking seamounts and mounds South of Afanasy Niktin (Fig. 7.11). SO258 leg 1 mapped these structures between ca 11°S and 7°45'S along ca. 81°30'E. According to paleomagnetic data the seafloor in this area formed between chrones C29N and C32N going from south to north (Desa et al. 2006), which corresponds to a period from ca. 64 Ma to 72 Ma. Most seamounts were successfully sampled at stations DR29 through DR34 and DR36 though DR38. Notably EM122 multi-beam mapping revealed a much higher abundance of seamounts than predicted by satellite altimetry most likely reflecting size / gravity of the features. The southern and northern termination of the "Southern Seamounts" could not be determined by SO258 leg 1 mapping due to time constraints. Based on their constant north-south strike in the mapped areas it appears, however, that the "Southern Seamounts" run just west of Afanasy Nikitin Complex and thus the two features show no morphological connection. Due to the lack of significant faulting affecting the edifices, they appear to have formed off-axis. Age dating of the seamount lavas in conjunction with age estimates for the underlying ocean crust will reveal if the "Southern Seamounts" formed continuously over an off-axis melting anomaly or during a single intra-plate event or discontinuous in a series of smaller, spatially irregular melting events.

The southernmost seamount (DR29 + DR30) is a circular cone that elevates from ca. 5,000 to 3,750 m b.s.l.. DR29 aimed at the upper portions of the W flank (4,480 – 4,010 m b.s.l.) and recovered very limited amounts of dense, aphyric, moderately altered pillow lava fragments. Still some chilled margins possess fresh glass. A second attempt was made along a small cone on the southwestern flank of the seamount (DR30, ca. 4,700 - 4,300 m.b.s.l) and delivered moderately altered, aphyric to rare Ol-phyric lava fragments (Fig 7.12). No fresh glass was obtained here.

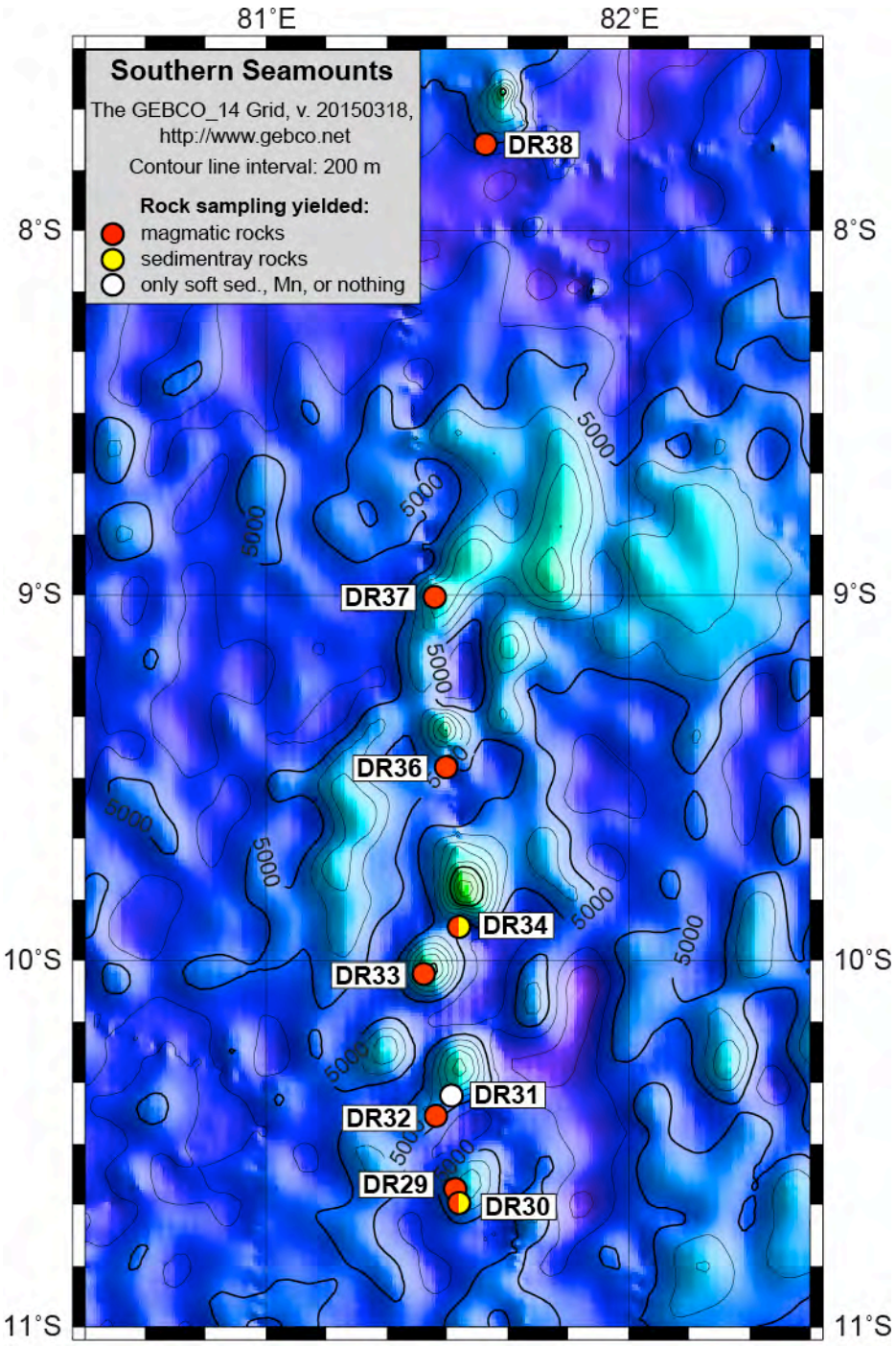


Fig. 7.11: Overview map showing the southern section of the "Southern Seamounts". Dots mark SO258 leg 1 sampling stations.

Seventeen nautical miles further north, another circular cone was targeted at its southwestern flank (DR31, 4,950 – 4,500 m b.s.l.) but returned only Mn-crusts. About 10 nm southwest of DR31 a small caldera volcano was aimed at DR32 (ca. 4,500 - 4,200 m b.s.l) and sampled the inner caldera walls. Dense, angular lava fragments of moderately to strongly altered rare Ol-phyric basalt were obtained (Fig 7.13). Samples appear suitable for bulk rock geochemistry, but age dating may prove difficult. Interestingly a single piece of relatively fresh, glassy pumice was also present in the dredge. The great water depth of 4,500 m makes an *in situ* origin less likely but rather a provenance by pumice raft from East Asian arc volcanoes. The source may be traced by analysis of the glass.

DR33 sampled the southwestern flank of a near flat-topped seamount between 4,400 and 3,900 m b.s.l. (Fig. 7.14) The flat summit is interpreted to reflect accumulation of pillow lava flows during the shield building stage of the volcano. Again only a few aphyric, dense pillow lava fragments were obtained. Small amounts of fresh Fsp and altered Ol-microphenocrysts are present in moderately to strongly oxidized groundmass. Fresh glass is observed in the chilled margin of DR33-1 while groundmass in DR33-2 is reasonably fresh (Fig 7.15).

Fig 7.12: Aphyric lava fragments with moderately altered groundmass from the southernmost "Southern Seamount".

Fig 7.13: Rare Ol-phyric lava with moderately altered groundmass from inner wall of a caldera volcano.

A more complex top area consisting of several small cones is present at station DR34, where the southwest facing flank of the seamount was sampled (ca. 4,300 - 3,900 m b.s.l., Fig. 7.14). Here, small amounts of slightly to moderately altered Plg-phyric pillow lava with fresh glass were recovered. The outer flanks of another caldera volcano were sampled at DR36 (ca. 4,300 - 3,950 m b.s.l., Fig. 7.14) and provided moderately to strongly altered ahyric lava (Fig 7.16) with fresh glassy margins in DR36-1 and -2. Similarly DR37 also returned only a few angular, moderately to strongly altered lava fragments but some with fresh glassy margins. Between DR37 and DR38 the series of north-south striking seamounts continues but could not be sampled due to time constraints. Therefore DR38 marks the northernmost extension of the "Southern Seamounts" mapped and sampled during SO258 leg 1. But the seamount chain is likely to extend further north. DR38 (ca. 4,700 - 4,300 m b.s.l.) sampled the upper eastern slope beneath a plateau like top and returned mostly Mn-nodules up to 15cm ø and a single, very altered aphyric basalt fragment recovered from a Mn-crust.

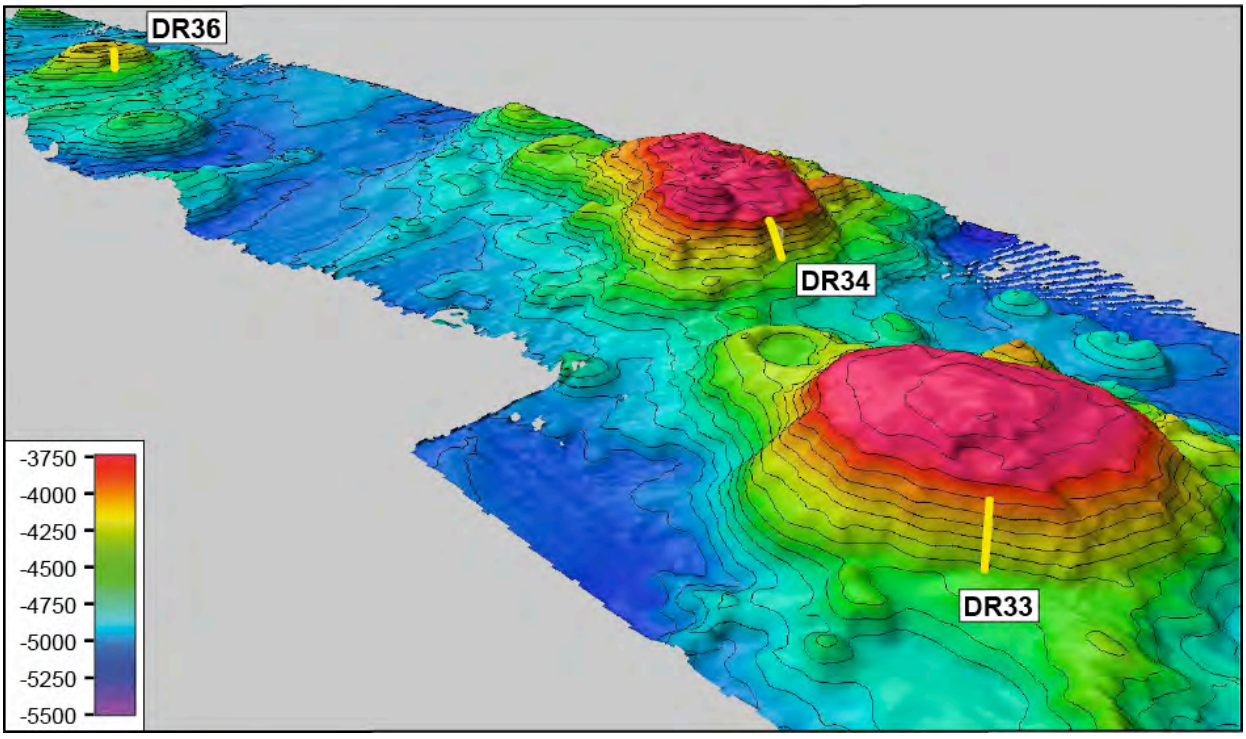


Fig. 7.14: 3D-Figure of the central part of the "Southern Seamounts" with dredge stations DR33, 34, and 36 (view from SW to NE). The map is based on multi-beam data recorded on SO258 leg 1 (stereo exaggeration: 2x; interval of contour lines: 100 m).

Fig 7.15: Slightly phyric lava with Ol-Fsp microphenocrysts from the flanks of a flat topped "Southern Seamount".

Fig 7.16: Moderately altered lava fragment with Fsp-mircophenocrysts from the outer flanks of caldera volcano in the center of the SO258 leg 1 survey area of the "Southern Seamounts".

Despite the surprising morphological variations and high abundance of volcanic cones within the "Southern Seamounts", sampling by dredge during SO258 leg 1 proved difficult in terms of recovered volume. Still recovery of fresh glass at most stations will for the first time allow pristine insights into their genesis. The predominance of aphyric pillow lava indicates fairly high degrees of melting with limited storage of melt in crustal reservoirs. One possible model to be tested is formation near the spreading axis where the melt column is still long enough to allow formation of tholeiitic (?) melts. Age dates, however, are crucial to relate formation of the seamounts to the age of the underlying ocean crust and to test for spatial age distribution. Material for Ar-Ar-dating, however, is limited to a single occurrence of Plg-phyric basalt and otherwise will rely on groundmass / microphenocryst dating or fresh glass. The great water depth of 4 - 5 km may, however, have prevented proper equilibration with atmospheric Argon at the time the melts froze.

7.1.2.4 Afanasy Nikitin Complex

The Afanasy Nikitin Complex is the focus area of mapping and rock sampling efforts during SO258 leg 1. The complex basically consists of a north-south elongated plateau between 2°10’S and 5°25’S at roughly 82°55’E (Fig. 7.17). It elevates from ca. 4,800 m b.s.l. of the surrounding abyssal plain to a mean plateau depth of 3,800 m b.s.l. North of 3°30’S, a series of larger volcanic cones elevates from the plateau to 1,549 m.b.s.l in its shallowest portions at Afanasy Nikitin Seamount (Krishna et al. 2014). The Afanasy Nikitin Complex is embraced by chrone C33 in the north and C32 in the south, which corresponds to a period from ca. 79 to 74 Ma for the ocean crust (Krishna et al. 2014). While the eastern boundary of the plateau gently dips into the abyssal plain, the western boundary is marked by a steep step that aligns with the north-south striking, right lateral 82°15’ fracture zone. Notably a series of east-west trending normal faults cut through the plateau, especially in its southern portion (Fig. 7.18) and may reflect imprint of an abyssal hill / spreading center fabric. Both observations (fracture zone at the western boundary and east-west trending normal faults) indicate that the Afanasy Nikitin complex formed near but north of a spreading segment in the Late Cretaceous. Available radiometric age data suggests that the seamounts in the north formed at ca. 68 Ma (Krishna et al 2014), which is ca. 10 Ma after formation of the underlying (plateau?) crust. SO258 leg 1 sampling efforts concentrated on sampling a north-south profile of the plateau phase by mainly targeting east-west striking normal faults in the south (Fig. 7.18) and along the entire western margin. The late stage seamount phase was targeted at the two largest cones / guyots to complement existing sampling. Basic questions are to reveal possible age progressive formation of the plateau from north to south and to decipher the cause of enhanced melting that led to the surplus of volcanism.

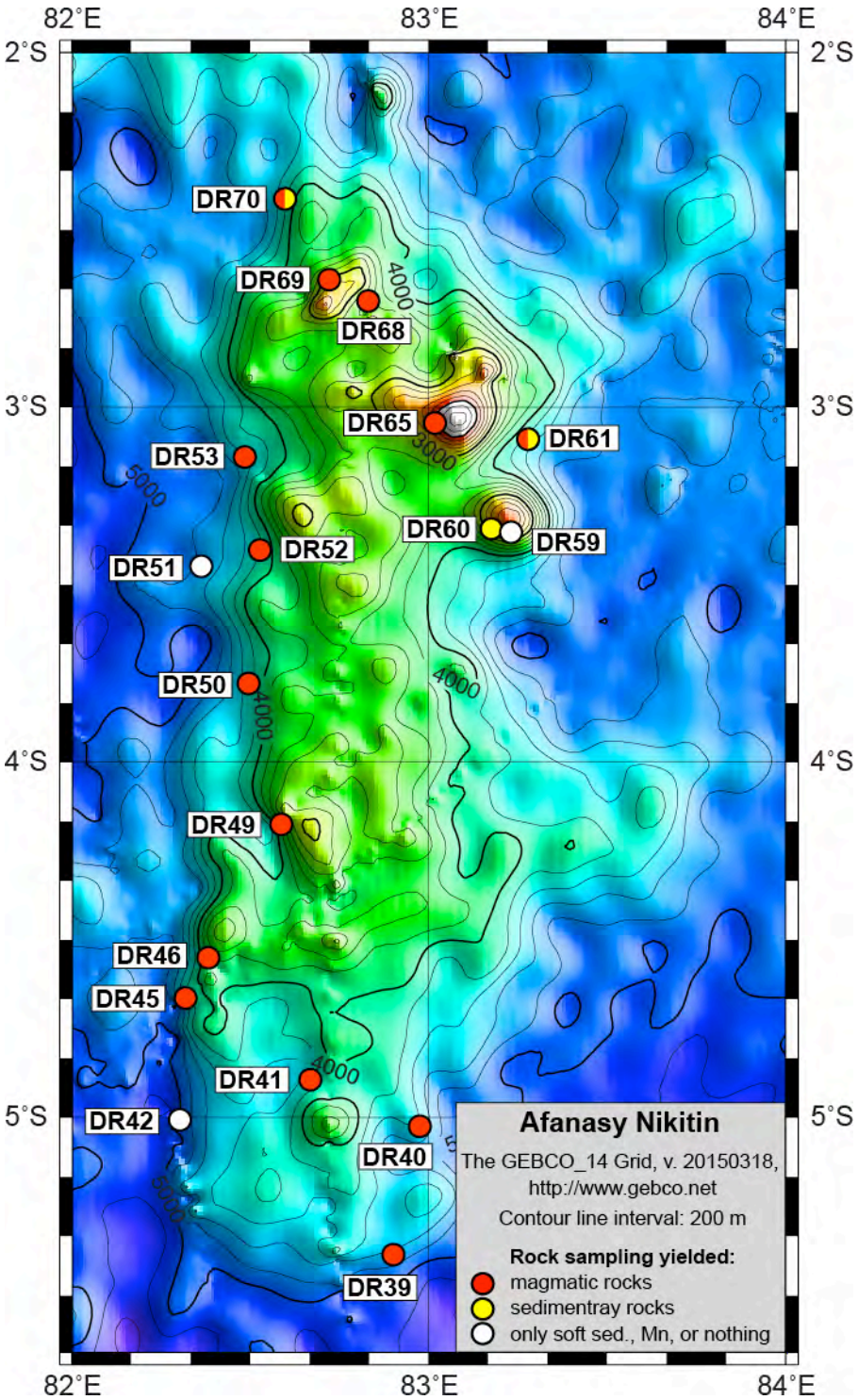


Fig. 7.17: Overview map showing the Afanasy Nikitin Complex. Dots mark SO258 leg 1 sampling stations.

Going from south to north, the first dredges were carried in the southern portion of the Afanasy Nikitin Complex and successfully aimed at the south dipping slopes of east-west striking normal faults (DR39 and DR40, Fig.7.18) and the base of a larger cone at DR41. DR39 (ca. 4,950 - 4,550 m b.s.l.) returned half full with a pleasing selection of surprisingly fresh pillow lava and sheet lava. Closer inspection revealed the presence of rare Ol-phyric, Ol-Plg-phyric (Fig 7.19), Plg-phyric and aphyric lava. Chilled margins containing fresh glass are apparently limited to the aphyric varieties. DR40 (4,750 - 4,430 m b.s.l.) obtained abundant crusts including Mn-crusts with only few magmatic rocks. They are moderately fresh Ol-phyric, Ol-Fsp-phyric and Fsp-Px-phyric lava fragments. Sample DR40-2 has a chilled margin but unlikely contains fresh glass. From the base along the northwestern flank of the largest seamount in the southern area, DR41 (ca. 4,200 - 3,800 m b.s.l.) returned angular lava fragments and crusts. The strongly altered pillow fragments possess minor Fsp-microphenocrysts and the chilled margins appear free of fresh glass.

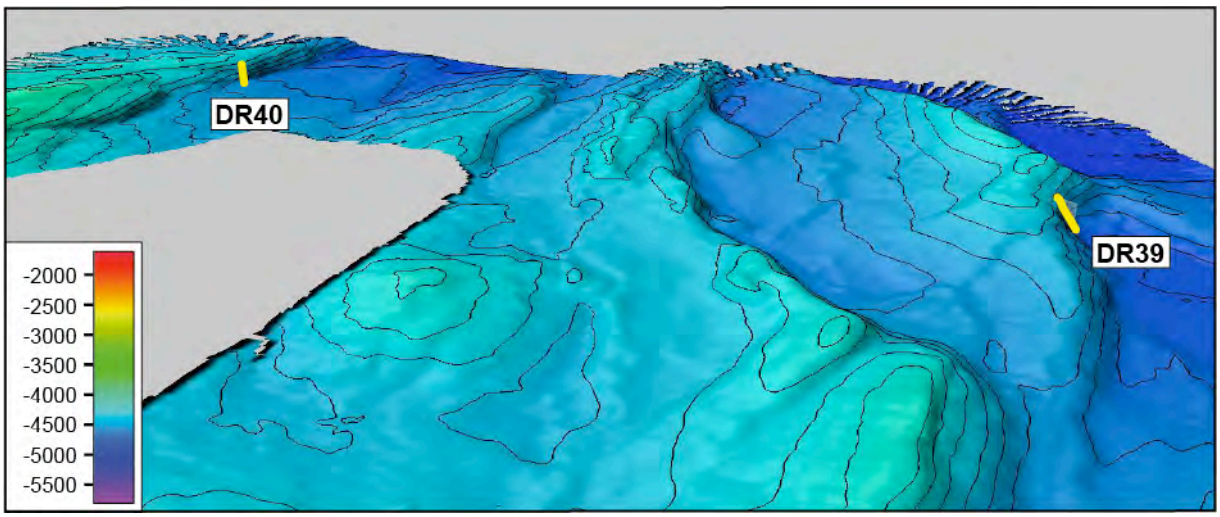


Fig. 7.18: East-west trending faults at the southernmost portion of the Afanasy Nikitin Complex with SO258 leg 1 dredge track DR39 and 40 (view from WSW to ENE). Stereo exaggeration, contours, and data sources as in figure 7.14.

Fig 7. 19: Slightly Ol-Plg-phyric lava with slightly altered groundmass from east-west striking normal fault in the southern part of the Afanasy Nikitin Complex.

Fig 7.20: Highly Ol-Plg-phyric lava with moderately altered groundmass from the western margin of the Afanasy Nikitin Complex.

The southernmost dredge DR42 (ca. 5,050 - 4,650 m b.s.l.) along the western margin of the Afanasy Nikitin Complex returned only Mn-nodules. The following dredges further north at DR45 (ca. 5,000 - 4,400 m b.s.l.) and DR46 (ca. 3,750 - 3,350 m b.s.l.) were more successful. At DR45 mostly basalts ranging from strongly Plg-phyric (50% crystals) to aphyric were obtained. Groundmass alteration ranges from strongly to moderately / weakly oxidized. Plg is fresh in most rocks and some are medium crystallized and may be suitable for matrix dating. Sample DR45-19 is unusual due to high vesicularity of clasts in this highly altered hyaloclastite. A presumably tectonic ridge was sampled at DR46. Here three different lava types were identified. 1) Ol-Plg-phyric basalt (samples -1 to -7 and 17) with moderately altered matrix but abundant large, fresh Plg that are good for Ar-Ar-dating (Fig 7.20), 2) Ol-phyric lava (-9, -10, -13) with up to 15-20% altered Ol (Ø 1mm) in a moderately altered matrix, 3) aphyric lava (-8, -11, -12) strongly altered matrix but -8 has chilled margin with fresh glass. Additional lithologies are strongly altered hyaloclastites that either have (-14) or potentially have (-15) fresh glass cores for spot analysis. The center portion of Afanasy Nikitin Complex along its western flank was targeted at DR49 (ca. 3,900 - 3,400 m b.s.l.) and DR50 (ca. 4,450 - 4,200 m

b.s.l.). Both locations returned only limited igneous material. Specifically DR49 gave a large, aphyric, strongly oxidized pillow fragment (DR49-2) with possible fresh glass in its chilled margin. Furthermore a small fragment of Plg-phyric lava (DR49-1) with moderately altered grayish groundmass and a hyaloclastite with minor fresh glass fragments were obtained. At DR50 very small fragments of fresh glassy Ol-Plg-basalt from a hyaloclastite and strongly oxidized Ol-basalt were recovered (Fig 7.21). A northwest-southeast striking (tectonic?) ridge at the very base of the western Afanasy Nikitin flank was aimed at DR51 (ca. 4,950 - 4,550 m b.s.l.) to possibly sample the deepest stratigraphic level, but unfortunately returned empty. Further upsection, DR52 (ca. 4,300 - 4,050 m b.s.l.) was carried out along a step in the western slope. In this area dives with a MIR submersible obtained Plg-phyric basalt. SO258 leg 1 DR52 obtained large fragments (up to Ø 70 cm) of aphyric pillow lava in a carbonate cemented breccia. Groundmass of some lava is fairly fresh and contains abundant small vesicles, but some are quite large (0.5 -10 cm!). Style of alteration and large vesicles suggest shallow water eruption. These observations indicate an origin in shallower water depth followed by 1,000 - 2,000 m down-slope transfer in the course of erosion. We note the presence of a larger bathymetric high immediately northeast of DR52 on the predicted bathymetry. A tiny seamount at the base of the western slope was sampled at DR53 (ca. 4,500 - 4,200 m b.s.l.) and obtained a large block of Plg-phyric pillow basalt with chilled margin that contains abundant fresh glass. The groundmass, however, is strongly oxidized throughout, but the Plg-crystals appear fresh and suitable for dating.

Fig 7.21: Fairly fresh clast of rare Ol-Plg-phyric lava recovered from a hyaloclastite at the central western margin of the Afanasy Nikitin Complex.

Fig 7.22: Aphyric, dense lava of probably trachytic composition. Dredged from a WNW-ESE striking scarp at the eastern margin of the Afanasy Nikitin Complex.

Next were two attempts to sample a large guyot (referred to as seamount C by Krishna et al. 2014) along its southern flank right beneath the plateau edge at DR59 (2,800 - 1400 m b.s.l.) and along mid-slope at DR60 (ca. 3,000 - 2,600 m b.s.l.). Despite numerous large bites the dredge was empty at DR59 and DR60 returned only carbonate and Mn crusts. Thus no volcanic rocks were obtained from seamount C. A prominent WNW-ESE striking fault at the eastern margin of the Afanasy Nikitin Plateau was sampled at DR61 and returned several fragments of dense, aphyric lava with flow banding structures. The latter indicate higher viscosity of the lava and likely reflects a more evolved, SiO_2 enriched melt of possibly trachytic composition. The pieces mainly differ in degree of oxidation and degree of groundmass crystallization. Sample -1 to -5 are most representative and suitable for geochemistry and whole rock Ar-Ar-dating (Fig 7.22) while sample -6 through -9 are chilled margins with fresh glass. It is speculated that eruption of these unusual melts is related to tectonic movements after emplacement of the Afanasy Nikitin plateau. A small seamount at the western footwall of Afanasy Nikitin Seamount was sampled at DR65 (ca. 2,700 - 2,300 m b.s.l., Fig. 7.23) and returned two large, up to 40 cm, lava blocks along with few small lava fragments. They are all vesicular Ol-Plg-phyric basalt throughout and DR65-1 has fresh glass in the chilled margin (Fig 7.24). Plg-phenocrysts are fresh and appear suitable for dating.

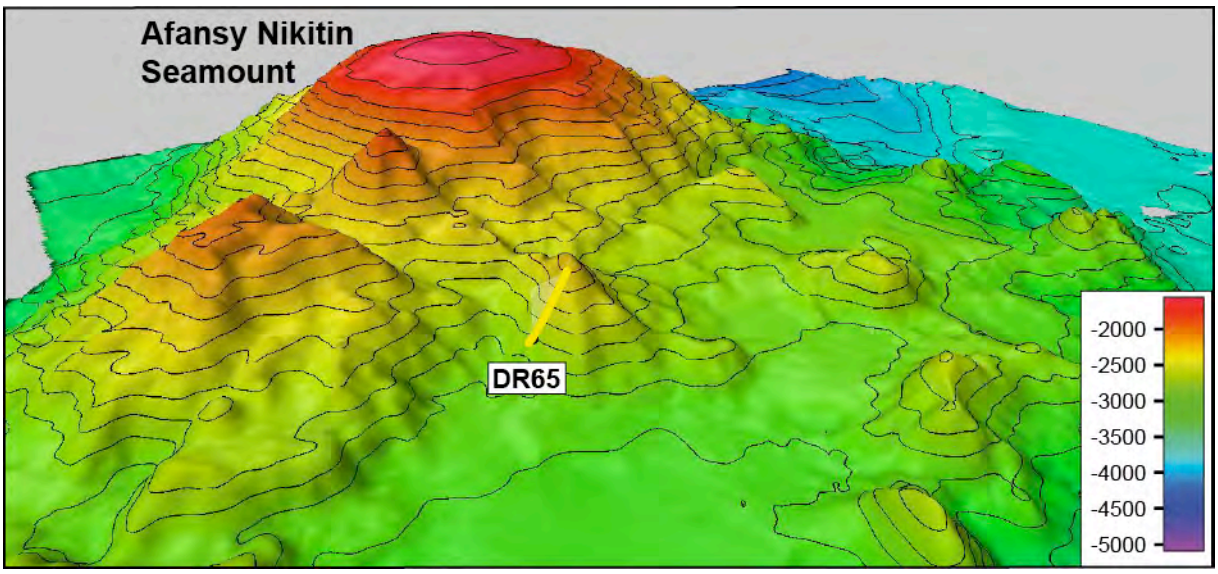


Fig. 7.23: 3D-Figure of Afanasy Nikitin Seamount. DR65 has been carried out at a small satellite cone at its western footwall (view from W to E). Stereo exaggeration, contours, and data sources as in figure 7.14.

Fig 7.24: Slightly altered Ol-Plg-phyric lava from a small cone along the southwestern flank of the Afanasy Nikitin Seamount.

Fig 7.25: Fairly fresh to slightly altered Ol-Px ± Plg-phyric lava from a small cone at the northwestern base of the Afanasy Nikitin Complex.

The final three stations aimed at the northwestern corner of Afanasy Nikitin. A full dredge of mostly Mn-crust was obtained from DR68 (ca. 3,100 - 2,650 m b.s.l.) along a small cone east of a plateau / seamount structure. Still a few loose lava fragments with centimeter thick Mn-crusts were recovered. All lava fragments are strongly altered, highly vesicular Ol-basalt. Some rare large 0.7 mm - 10 mm megacrysts of Ol contain large 0.2 - 0.3 mm Cr-Spinel inclusions. A single large block of Ol-phyric basalt was obtained from the northwestern slope of the aforementioned plateau / seamount structure at DR69 (ca. 3,300 - 2,650 m b.s.l.). In detail the sample features the transition of the glassy to more crystallized lava as is typical across (pillow) lava tubes. Ol-phenocrysts are quite abundant (10%), 3 mm in diameter but oxidized, whereas Plg-microphenocrysts appear fresh. The final station DR70 was carried out at the northwestern tip of the Afanasy Nikitin Complex and aimed at a small cone along the base of the western flank (ca. 4,100 - 3,700 m b.s.l.). Although only a few rocks were obtained three different lava types were distinguished: 1) a more evolved, more viscous lava (sample -1) with altered Fsp but overall only slightly altered groundmass; 2) Ol-Px±Plg-phyric lava (-2, -6 and -7); containing most notably large millimeter-sized, fresh Px but Fsp appears altered (Fig

7.25) and 3) aphyric lava (-3, -4, -5) recovered from a breccia that is moderately altered and contains Ol / Px in the groundmass. In summary, SO258 leg 1 dredge operations at the Afanasy Niktin Complex returned a full suite of variably altered rocks but often with fresh glass. Notable are the frequent occurrence of Ol-phyric lavas indicating presence of relatively primitive melts. While the Afanasy Nikitin plateau stage could be sampled throughout the entire north-south extension, sampling of the late stage seamounts, in particular the two guyots in the north were less successful and returned only a single Ol-Plg-phyric lava from Afanasy Nikitin Seamount.

7.1.2.5 Buried Hills

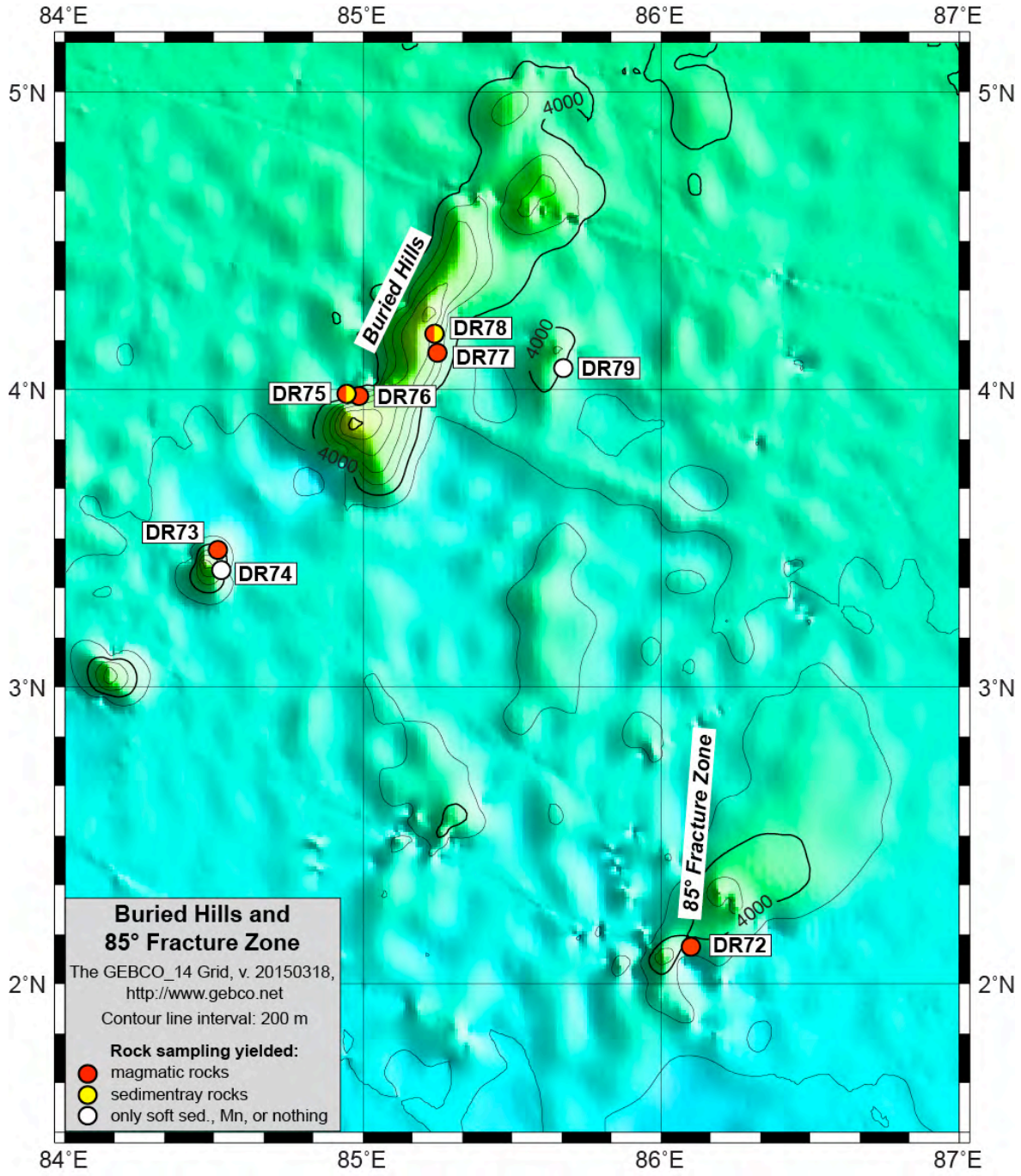


Fig. 7.26: Overview map showing the Buried Hills and the abyssal hill sampled by DR72 on the northern section of the 85° Fracture Zone (see chapter 7.1.2.2). Dots mark SO258 leg 1 sampling stations.

The Buried Hills refer to a series of ± northeast-southwest aligned conical seamounts and ridges in the northernmost SO258 leg 1 working area between 3°S and 5°S in the vicinity of

85°E (Fig. 7.26). They are located on ocean crust where east-west striking chrones C34-C33 (ca. 120 - 80 Ma) intersect with the northeast-southwest striking M2 chrone (128 Ma) along the 85° Fracture Zone (Desa et al. 2006). Note that chrones M11 to M0 (ca. 136 - 124 Ma) make up the ocean floor immediately south and southeast of Sri Lanka (Desa et al. 2006). Interestingly the strike of the partly buried hills follows the M chrone fabric implying that the melts leading to their formation used pre-existing crustal weaknesses. The name of the seamounts arises from the fact that they become progressively buried by sediment derived from the Bengal Fan in the north.

The southernmost cone of the Buried Hills could not be dredged as it lies at the intersection of two sea cables. A flat-topped seamount was targeted at DR73 (ca. 4,050 - 3,600 m b.s.l.) and DR74 (ca. 4,100 - 3,700 m b.s.l.) along its northern and western slope, respectively. DR73 returned Mn-crusts and Mn-encrusted, highly altered hyaloclastites. Moderately altered, slightly Ol-Fsp-phyric lava fragments were excavated from the Mn-crust (Fig 7.27). DR74 returned empty.

Fig 7.27: Slightly Ol-Plg-phyric lava with moderately oxidized groundmass recovered as clast from a Mn-crust obtained from a conical seamount at the Buried Hills in the northernmost SO258 leg 1 working area.

Fig 7.28: Aphyric lava clast with moderately altered groundmass recovered from a breccia at the northern slope of a NNE-SSW striking ridge.

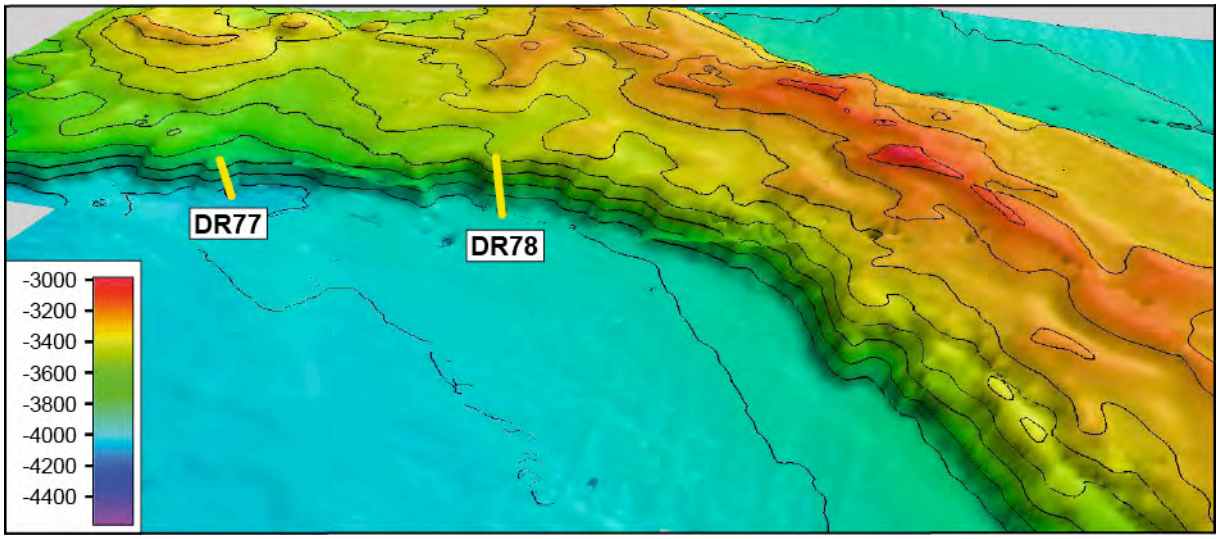


Fig. 7.29: 3D-Figure of dredge tracks DR77 and 78 at a NNE-SSW-striking ridge representing the largest volcanic feature of the Buried Hills (view from ENE to WSW). Stereo exaggeration, contours, and data sources as in figure 7.14.

The next two locations aimed at the northern slope of a NNE-SSW striking ridge. DR75 (ca. 4,050 - 3,600 m b.s.l.) obtained mostly moderately altered aphyric lava fragments from a

breccia. Sample 75-1 is a small but fairly fresh, angular basalt clast with rare Plg-Ol-phenocrysts of which the Plg-crystals appear suitable for Ar-Ar-dating. Nearby DR76 (ca. 3,750 - 3,500 m b.s.l.) also returned breccias from which angular, moderately altered, aphyric lava fragments were separated (Fig 7.28). In addition volcaniclastic rocks with partly glassy fragments were found. Further east, the eastern flank of the NNE-SSW-striking ridge was probed at DR77 (ca. 4,000 - 3,700 m b.s.l.) and DR78 (ca. 3,800 - 3,500 m b.s.l.) (Fig. 7.29). While DR77 returned a few fragments of highly oxidized, slightly Plg-Ol-phyric lava, DR78 returned only a single small piece of coarse grained, moderately altered, slightly vesicular lava. The groundmass consists of altered Ol, ±fresh Cpx and fresh Plg. The last station of SO258-1 was carried out along a less pronounced bathymetric high east of the NNE-SSW striking ridge. DR79 (ca. 4,100 - 3,850 m.b.s.l) returned only semi-consolidated limestone mud.

In summary, SO258 leg 1 sampled the Buried Hills at basically two locations, a circular cone and the southern part of the prominent NNE-SSW striking ridge. The recovered rocks mainly comprise Mn-crusts and Mn-encrusted breccias with angular clasts of mainly aphyric lava and subordinate slightly Plg-Ol-phyric varieties. Fresh glass might be present in some of the volcaniclastic rocks. The slopes of the sampled bathymetric features appear mainly covered by consolidated breccias and Mn-crusts. The obtained material is suitable to obtain basic geochemical information and a few selected samples appear suitable for Ar-Ar-dating.

7.2 BIOLOGICAL INVESTIGATIONS

7.2.1 Methods

(J. Marshall, F. de Busserolles, W-S Chun, F. Cortesi)

7.2.1.1 Tucker Trawl

During the cruise Tucker trawling was interspersed with geological dredges and benthic lander operations. The resulting pattern of work was effective, giving enough time between trawls to work up samples and repair nets and control systems. Usually each trawl was accompanied with a plankton net deployment from the starboard side of the vessel to catch neuston-level (surface to 2 m depth) life.

In all 25 trawls were shot. Most recoveries were during hours of darkness to bring animals on board in a dark-adapted state for various visual physiology experiments conducted on board. Trawls were generally of two types, either shallow and short or deeper and longer and varied from around 1,500 m to 150 m. Two example profiles are plotted below (Fig. 7.30).

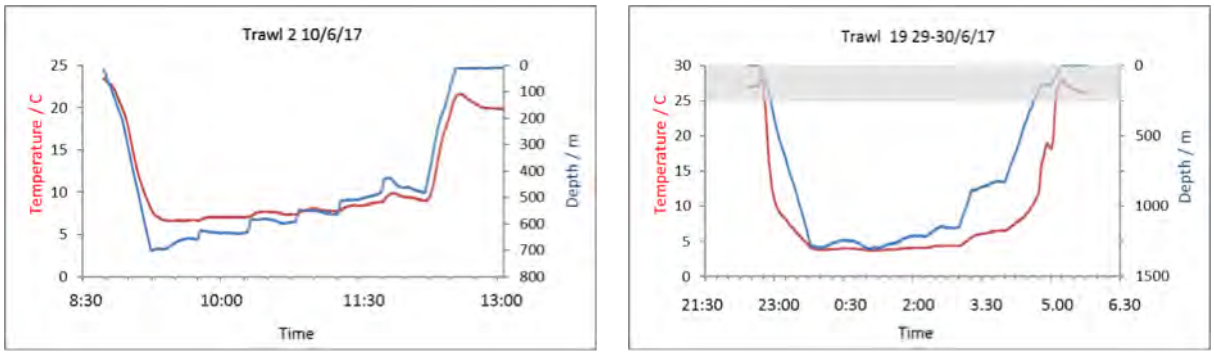


Fig. 7.30: Example Tucker trawl profiles showing depth and temperature. Grey bar indicates hours of dark. All station details are plotted in Appendix IV .

Equipment and Catching Performance

The design of this Tucker trawl was experimental, in general a scaled-up version of the RMT 8 (Rectangular Mid-water Trawl, with 8m^2 opening). As previously with the SO209 cruise (RMT 16 custom-designed for that vessel during the Deep-Australia Project), the net used here was also designed to fit within the A-frame of the new SONNE. The result is one of the largest RMTs ever deployed with a 35 - 40 m^2 opening (9 m x 5 m when fully vertical). This required a few modifications including a front-section with large mesh (1 - 5cm) to reduce the overall drag and a general scaling-up of the net bars and cables used. Behind the front section, a second section of net was included with more typical RMT mesh of 5 mm and a final section with ½ mm plankton mesh before the bucket-style cod-end. Figure 7.31 below shows some of these features.

In general this net system performed well and the catch included many living and good condition specimens, dependent on depth sampled from and trawl time. For this reason, the closing cod-end systems available were not used. Both the large area of opening and gradual taper of the net contributed to catch volume which still rarely exceeded the volume of the bucket cod end at around 20 liter.

The scaling up of the system caused some problems and failures. For example, the net bar controller which enables opening and closing of the net at discrete depths failed mechanically after the first week. This was because of the increased load and drag on the opening and closing mechanism, so for future cruises, this unit will need some modification. There were also intermittent failures of the depth sensors used also suggesting modifications needed.

As a result, all net deployments after the first week were with the net open all the time; a situation that suited all projects conducted there being no quantitative or geographical data required.

The added load to the net bars also caused some bending of the upper bar which was lashed to the control bar to prevent further bending, again a solution that worked well but that needs some attention for future net modifications.

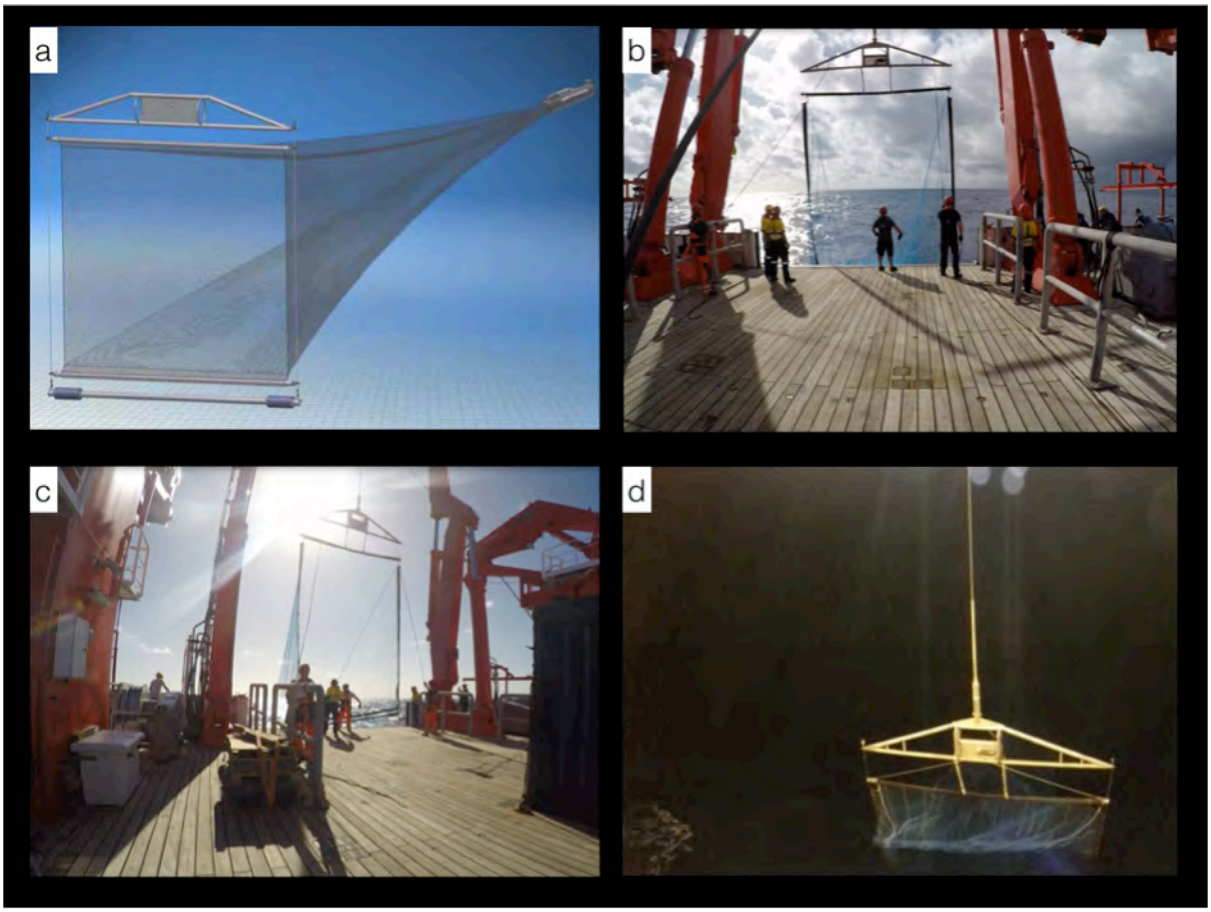


Fig. 7.31: Rectangular midwater trawl (RMT) net design and operation. (a) Drawing of RMT 25 net. (b - d) net operation. (Photos: W.-S. Chun)

7.2.1.2 Neuston Net Catches

During most Tucker trawls a small (2 x 1 m, 1 mm mesh) plankton net was deployed over the starboard side of the ship to catch life in the top 2 m of the ocean. Typical catches included flying fish, myctophids at night time and a variety of zooplankton as well as the ocean insect *Halabates sp*.

7.2.1.3 Lander Types and Deployments

(A. Jamieson, T. Linley, N. Cuomo)

Five autonomous lander systems (3 imaging landers and 2 trap landers) were successfully deployed and recovered 17 times during cruise 258 leg 1 (Table 1).

Table 1: Lander deployments. Dep (deployment number), Area WAT (West Australian Trough) or ANS (Afanasi Nikitini Seamount).

Dep	Date	Lander	Lat	Long	Area	Depth (m)
1	10/06/2017	Lander 1	-22.19715	102.50257	WAT	4730
2	10/06/2017	Lander 2	-22.21235	102.50430	WAT	4990
3	10/06/2017	Lander 3	-22.22902	102.49192	WAT	5274
4	10/06/2017	Trap	-22.24290	102.47103	WAT	5990
5	10/06/2017	Deep Lander	-22.26552	102.44128	WAT	6537
6	11/06/2017	Lander 3	-22.19830	102.50368	WAT	4767
7	11/06/2017	Trap	-22.20965	102.50578	WAT	4932
8	11/06/2017	Rocket Trap	-22.24380	102.46728	WAT	6068

Table 1 (continued)

Dep	Date	Lander	Lat	Long	Area	Depth (m)
9	11/06/2017	Deep Lander	-22.24812	102.42358	WAT	6546
10	12/06/2017	Deep Lander	-22.24898	102.45923	WAT	6162
11	12/06/2017	Lander 3	-22.24550	102.46532	WAT	6084
12	29/06/2017	Lander 3	-3.14887	82.43345	ANS	4724
13	29/06/2017	Trap	-3.15393	82.43310	ANS	4733
14	29/06/2017	Deep Lander	-3.15903	82.43322	ANS	4757
15	01/07/2017	Lander 3	-3.03700	83.09400	ANS	1584
16	01/07/2017	Lander 2	-3.03317	83.09117	ANS	1567
17	01/07/2017	Trap	-3.02983	83.08833	ANS	1560

7.2.2 General Description of Catch

(J. Marshall, F. de Busserolles, W.-S. Chun, F. Cortesi, T. Frank)

Over 150 species of fish from 81 genera and 38 families were caught. These were typical of the mesopelagic assemblage but included interesting abundancies and exclusions. For example, only 3 juvenile *Anoplogaster* were caught and no *Diretmus sp*, while many *Stylephorous* (11) were caught along with stomiiforms from at least 22 genera including hundreds of hatchetfish (Stenoptix and Argyropelecus), viperfish (Chauliodus), bristlemouth (Gonostoma) and the rare *Malacosteus niger* or *australis* (22 individuals) and *Eustomias sp* (28 Individuals).

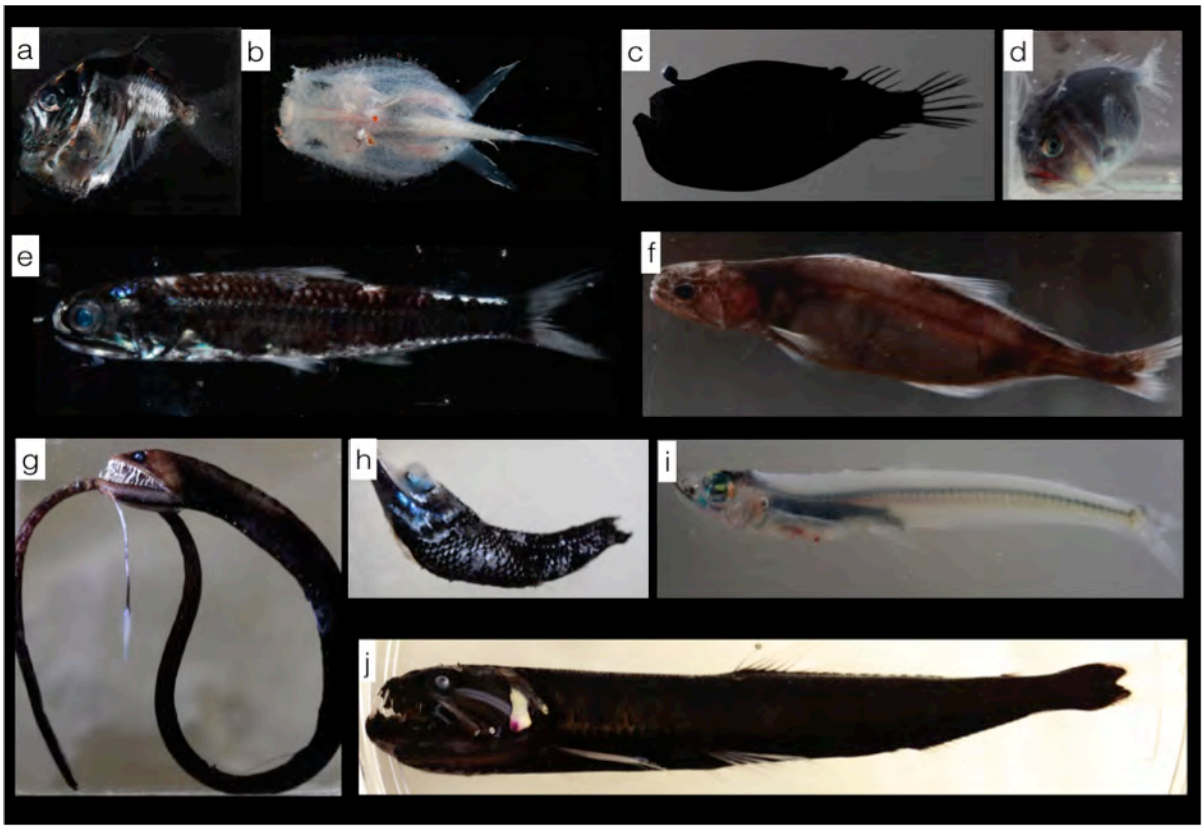


Fig. 7.32: A few examples of mesopelagic fish caught during SO258 leg 1. (Photos: W.-S. Chun)

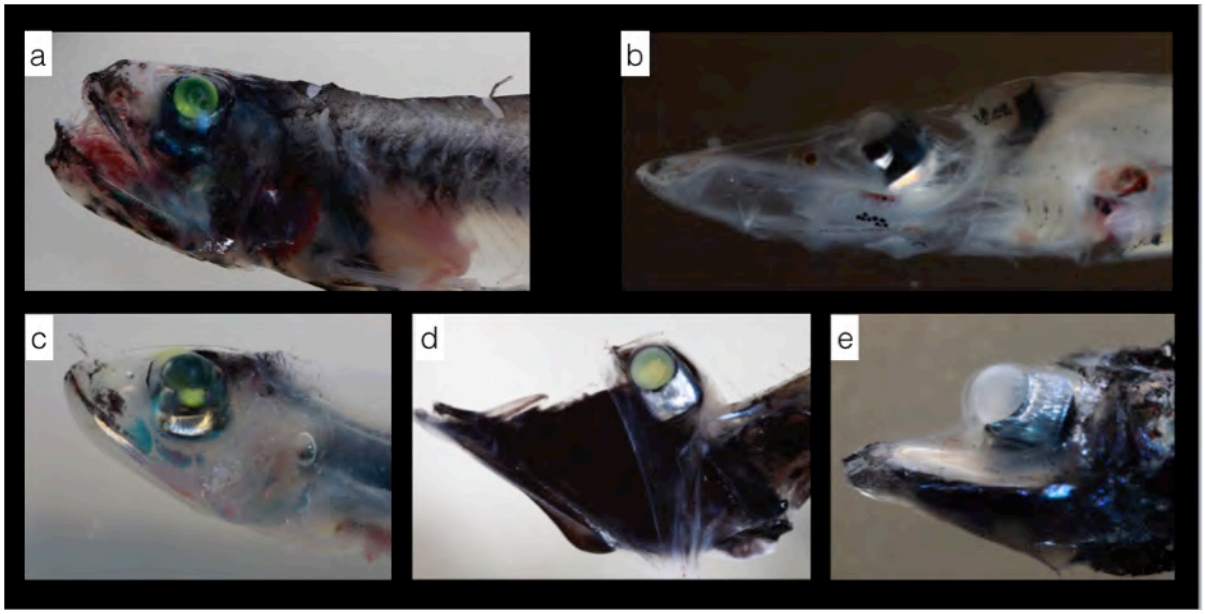


Fig. 7.33: Some examples of tube-eyed fish. (Photos: W.-S. Chun)

The diversity of cephalopods was unexpectedly large with 33 cephalopod species (225 specimens from 17 Families and 27 Genera) brought on board (see below).

Crustaceans included many decapod shrimp, hyperiid amphipods, ostracods and an assortment of other isopods and amphipods. The catch, like fish, was again in some ways typical of what was to be expected in mesopelagic trawls but with some gaps. The decapod crustaceans are described in chapter 7.2.3.13.

A full list of species of fish, crustaceans and cephalopods is provided in Appendix V. At the time of writing, taxonomic identification of species in many cases remains tentative and requires confirmation in collaboration with experts in the field of taxonomy. A few examples of fish caught are included in figures 7.32 and 7.33.

The crustacean abundance was dominated, for the most part, by families Oplophoridae and Sergestidae, which is common for subtropical and tropical waters. The biomass was similarly dominated by these two families, with the exceptions of a few very deep trawls where several enormous *Bentheuphausia amblyops*, the largest and deepest living species in the order Euphausiacea, skewed the biomass towards the euphausiids. Interestingly, the most abundant species varied with location. In the southernmost stations (trawls 2-7), the trawls were domi-nated by the oplophorids, primarily species of *Oplophorus spinosus*, *Systellaspis debilis*, and several A*canthephyra sp*. Not a single *Janicella spinacauda*, which usually co-occurs with these species, was caught until Trawl 16, a more northern station, at which point the *Oplophorus* were virtually non-existent, not reappearing until Trawl 20 (a different species this time, *Oplophoris gracilirostris* not *spinosus*), and then in substantially lower numbers than at the southern stations. The sergestid genera, *Sergia* and S*ergestes* (now revised into 5 different genera), were also much more abundant in the southern vs. the northern stations. Trawl 16 is also where large numbers of the big red lophogastrid, *Gnathophausia ingens*, quite rare in the southern stations, appeared in substantial numbers (20 in trawl 16 alone). By trawl 18, the *Sergia* were in abundances equivalent to what was seen in the southern stations (15 - 20 / trawl), but the *Sergestes* species were quite rare (3 - 4 / trawl). It will be interesting to see if there is any correlation between the presence and absence of shallow seamounts, based on the data by the geology group. Pandalidae, a family of particular interest of for my physiological experiments, were not geographically variable and not very common, with only 2 - 3 per trawl throughout. Thalissocarideans, the other group of interest, were non-existent, and although reported as being relatively common in the Indian Ocean, are probably present in more coastal waters.

7.2.3 Investigations and Experiments with Fish, Cephalopods and Crustaceans

7.2.3.1 Visual Ecology and Sensory Systems in Deep-Sea Fishes from a Brain Perspective

(J. Marshall, F. de Busserolles, F. Cortesi)

This project will focus on lanternfishes, in collaboration with Prof. Kara Yopak (University of North Carolina Wilmington), and Prof. Shaun Collin (University of Western Australia) and Prof. Hans-Joachim Wagner (Universität Tübingen).

Myctophidae (lanternfish) is one of the most abundant families of mesopelagic (200 - 1,000 m) fishes, with more than 250 representatives, and occupies all of the world's oceans. They are bioluminescent and are part of the largest animal migration we know of, a diel vertical migration towards the surface at night in order to feed and a return to the depths (up to 1,000 m) to avoid predation from surface dwellers. Recently, their visual system was investigated into detail (including species from previous SONNE cruises) and results showed a huge interspecific variability in eye designs at all levels, from the structure as a whole (i.e. eye size) to the individual cells (i.e. rod photoreceptor size) suggesting that some species might rely more on vision than others (Fig. 7.34).

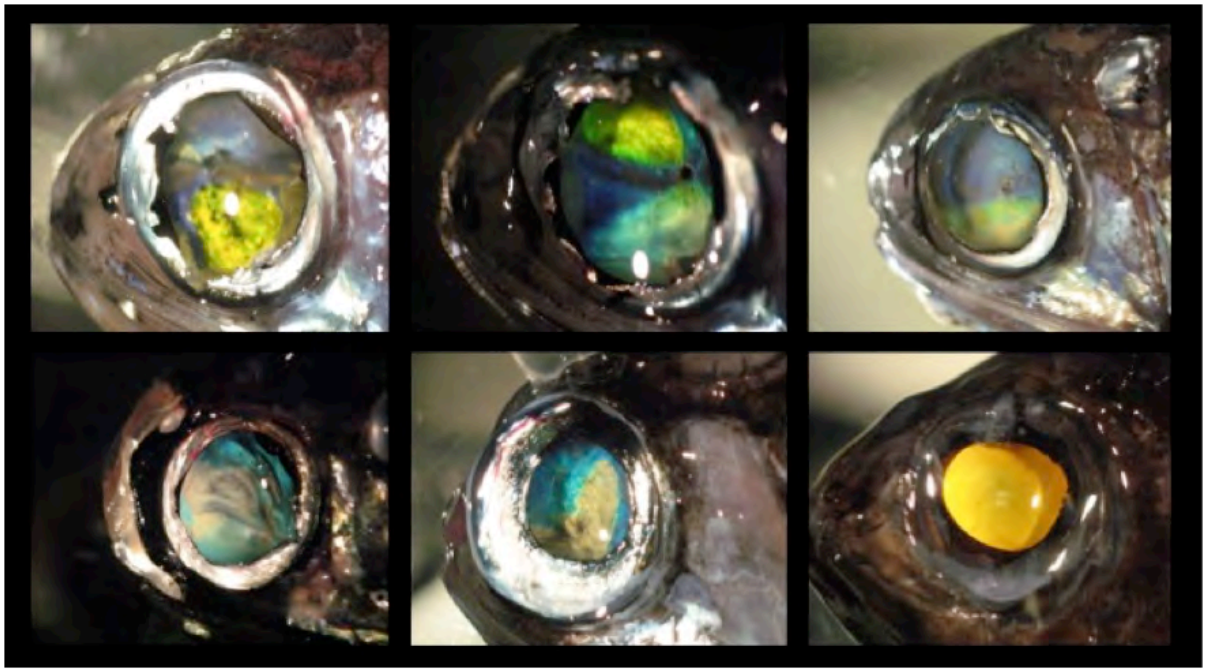


Fig. 7.34: Some example of the diversity in appearance of the retina and tapetum coloration found in deep-sea fishes, especially lanternfishes. (Photos: F. de Busserolles)

Previous studies have shown that the structure and size of the different brain areas clearly reflect sensory specializations in teleost fishes. Since the optic tectum is the main centre for image processing by receiving visual input directly from the retinal ganglion cells via the optic nerve, analysis of its relative proportion can provide information about the importance of the visual system of a particular species. Therefore, to confirm whether some lanternfish species rely more on vision than others and assess what other sensory systems they preferentially rely on, we will investigate brain structure and size of different lanternfish species. Relationships between brain area dimensions and the preferred environmental conditions of each species (i.e. depth) will be assessed taking into account the evolutionary history of the family.

The samples collected during this trip will complete a collection of specimens acquired over the past years during several other cruises, including two previous SONNE cruises (SO209/1 and SO234/1). With these additional samples, we estimate that this study will include over 60 species of lanternfish, representing more than 50% of the recognized genera and provide a significant contribution to the understanding of deep-sea fishes ecology and behavior.

7.2.3.2 Mesopelagic Fish Sexual Dimorphism and Visual Ecology

(*J. Marshall, F. de Busserolles, F. Cortesi*)

Many deep-sea fish are bioluminescent, possessing luminous organs that emit light signals for either camouflage purposes or for some form of interaction with prey (attraction), predators (repletion/distraction) and/or congeners (communication). In addition, several species present a sexual dimorphism in their luminous organs, supposedly used for communication between mates. Although differences in light spectra output between males and females of sexually dimorphic species have never been investigated, two recent examples of sexual dimorphism in the visual system of sexually dimorphic lanternfishes suggest that color signals may be used as a private communication channel between mates. The aim of this project is to assess whether behavioral sexual dimorphism is reflected in the visual system. The study will also focus on lanternfishes, which includes both sexually and non-sexually dimorphic species in terms of their luminous organs. The visual system of 6 species, 3 sexually and 3 non-sexually dimorphic, will be investigated in males and females at the molecular and morphological levels using RNA-seq, in situ hybridisation, histology, microscopy, TEM, and retinal topography, as above. The samples collected during this trip will complete a collection of specimens acquired over the past years during several other cruises, including two previous SONNE cruises (SO209/1 and SO234/1).

7.2.3.3 Transcriptomics of Mesopelagic Fish

(*J. Marshall, F. Cortesi*)

Recent findings by our lab suggest that some deep-sea fish might have independently evolved the ability to see color in the dark. Although the deep-sea is characterized as being one of the dimmest environment on earth, bioluminescence, produced by the animal themselves, is common and occurs in several forms, such as flashes, spews and glows that cover a surprisingly wide range of the visible spectrum. Light signals in the deep-sea vary in spectral composition, and these species might have evolved a way to discriminate different bioluminescent signals. The visual system of representatives from several deep-sea fish lineages collected during this trip will be sequenced to try to verify our hypothesis.

7.2.3.4 Collaborative Fish Work

(*J. Marshall, F. Cortesi*)

Several of the deep-sea fish tissue collected will be used for the following collaborative projects:

Genomic sequencing of deep-sea fishes: This project is done in collaboration with colleagues at the Sanger Institute in the UK (Richard Durbin). The objective is to use third generation sequencing approaches (long-read sequencing) to gain high quality reference genomes for one fish species per order. A number of orders only contain deep-sea species, which are very difficult to come by especially when fresh tissue is needed for DNA work. The new net and very favourable weather conditions have made it possible to sample rare species including several barreleye species (Argentiniformes) and the monotypic *Stylephorus chordatus* (Stylephoriformes).

Chromophore A1/A2: Most freshwater fishes use an A2-based chromophore for vision while marine fishes usually use an A1-based chromophore. Few lanternfish species, however appear to use a combination of both. Together with Joseph Corbo and his team from the Washington University, we will be investigating the molecular mechanism for A1/A2 in these fishes.

Deep-sea fish haemoglobin: This project will be done in collaboration with Stuart Fraser from the University of Sydney. Stuart and his team will be investigating red blood cell morphology and genomics in stomiiformes.

Deep-sea fish olfaction: Olfaction is an important sense for deep-sea species. Taking advantage of the numerous samples collected during this cruise we will perform a genomic and morphological comparative analysis of deep-sea fishes olfactory organs. This will be done in collaboration with Zuzana Musilova from Charles University in Prague.

7.2.3.5 Visual Pigment Regeneration

(*J. Partridge, A.-L. Jessop)*

Deep-sea fish live in an environment characterized by very low light levels, regardless of whether the light is from the sun or from bioluminescence. Daylight irradiance decreases rapidly with depth and at 500 m, even at midday at tropical latitudes and in the clearest ocean waters, light levels for vision are low, and many orders of magnitude less than that at the surface. At all other geographic locations, in overcast weather conditions, in more eutrophic seas, and at other times of day, daylight experienced by deep sea animals will be lower still. At night light from bioluminescence predominates, but even when bioluminescent point sources are visible as high contrast emissions seen against a virtually black background, the photon flux attributable to such sources is small.

Despite living in near darkness, almost all deep-sea fish have well developed eyes and vision is clearly an important sensory modality likely to underpin a range of key behaviors including predation, predator avoidance, mate identification and, probably, even mate selection. The visual pigments of many deep-sea fish have been studied in detail (e.g. Douglas et al., 1998). The great majority of these fish have light-sensitive rod photoreceptors that contain rhodopsin visual pigments, with retinas most often dominated by one rhodopsin, an RH1 opsin combined with 11-cis-retinal as a chromophore. In almost all deep-sea fish studied the predominant, or even only, visual pigments found in their retinae have a peak absorbance at a wavelength (λ_{max}) close to 480 nm (e.g. Hunt et al., 2001). When rod visual pigments are exposed to light, the chromophore changes its conformation from the light-sensitive 11-cis isomer to all-trans retinal, a conformational change that coincides with the initiation of a transduction cascade within the rod that leads to hyperpolarization of the cell and the reduction in release of neurotransmitter at the cell synapse (e.g. Lamb 2006). This is the basic neural signal underpinning vertebrate vision, including that of deep sea fish. Once formed, all-trans retinal is no longer bound to the opsin via a stable Schiff's base at the retinal binding site located within the palisade of 7 trans-membrane domains of the opsin molecule, as is the case with 11-cis retinal. Instead it detaches from the opsin and is actively transported to cells of the retinal pigment epithelium (RPE) for re-isomerization to 11-cis-retinal. The freshly re-isomerized chromophore is then transported back to the rod outer segment rejoining an opsin molecule to form a 'regenerated' visual pigment. This process of regeneration maintains the animals' visual sensitivity and, to our knowledge, is common to almost all vertebrates (see Lamb 2006 for an overview).

As deep-sea fish live in such low light levels, the question arises about their capacity for visual pigment regeneration. It has even been suggested, based on histological evidence of their retinas (specifically the anatomical relationship between RPE cells and photoreceptors), that they may not routinely regenerate visual pigment at all, being instead dependent on the slow cycling of visual pigment that takes place in the normal course of rod outer segment membrane turnover. If their capacity to regenerate their visual pigments is low, this may make deep sea fish vulnerable to bright artificial lights, such as those used on remotely operated vehicles and submersibles, and exposure to such lights has potential to cause temporary or even permanent blindness (as is known to occur in some deep sea crustaceans). To assess the ability of deep-sea fish to regenerate their visual pigments after exposure to light levels outside their normal environmental conditions we therefore tried two approaches: electrophysiology and spectrophotometry.

Our electrophysiological method involved measurement of the electroretinogram (ERG) of deep-sea fish. The ERG is a measure of the extracellular field potential produced by the summed electrical activity of the retina and this signal has the advantage of being relatively robust and less sensitive to noise and vibration than intracellular recordings. Moreover, ERGs do not require work on live animals as tissue preparations (e.g. isolated eyes, eye cups, or even isolated retinas) can often be obtained from recently dead animals and yet used to provide high quality data revealing much about retinal function, including spatio-temporal sensitivity, contrast sensitivity, spectral sensitivity etc. In this study we used eye-cup preparations and platinum wire and/or silver/silver chloride electrodes to measure the retinal ERG in response to flashes from a white light emitting diode (LED) controlled by a microcontroller. The small inherent signal (ca. 1mV+) was amplified and band-passed filtered by an AC-coupled amplifier, and digitized by a National Instruments analogue to digital

converter before being recorded and visualized on a laptop PC using custom made software scripted in Matlab (Mathworks). The experimental apparatus, developed by our colleague Dr Jan Hemmi at the UWA, has been well proven in our laboratory where it is used regularly to measure ERGs in a range of invertebrates and vertebrates, including fish, providing high signal to noise recordings. Our aim was to measure the ERG of deep-sea fishes to assess how quickly their retinae 'fatigue' in response to a series of light flashes, and how quickly it recovers after exposure to bright light. Whilst at sea, the instrument was tested with both non-decapod crustaceans and with epipelagic scombrid fish (using the isolated eye cup method), demonstrating it was working as expected. Nevertheless, no ERG signal could be detected from any of the 15 deep-sea fish, from a range of families including Myctophidae, Sternoptycidae, and Gonostomatidae, which we tried. We have to conclude that, for reasons of retinal biology yet to be understood but possibly related to the thinness of their retinas and the paucity of neurons and glial cells in the inner retina, these animals do not produce a large enough ERG signal, even for a high quality ERG apparatus such as ours, to measure.

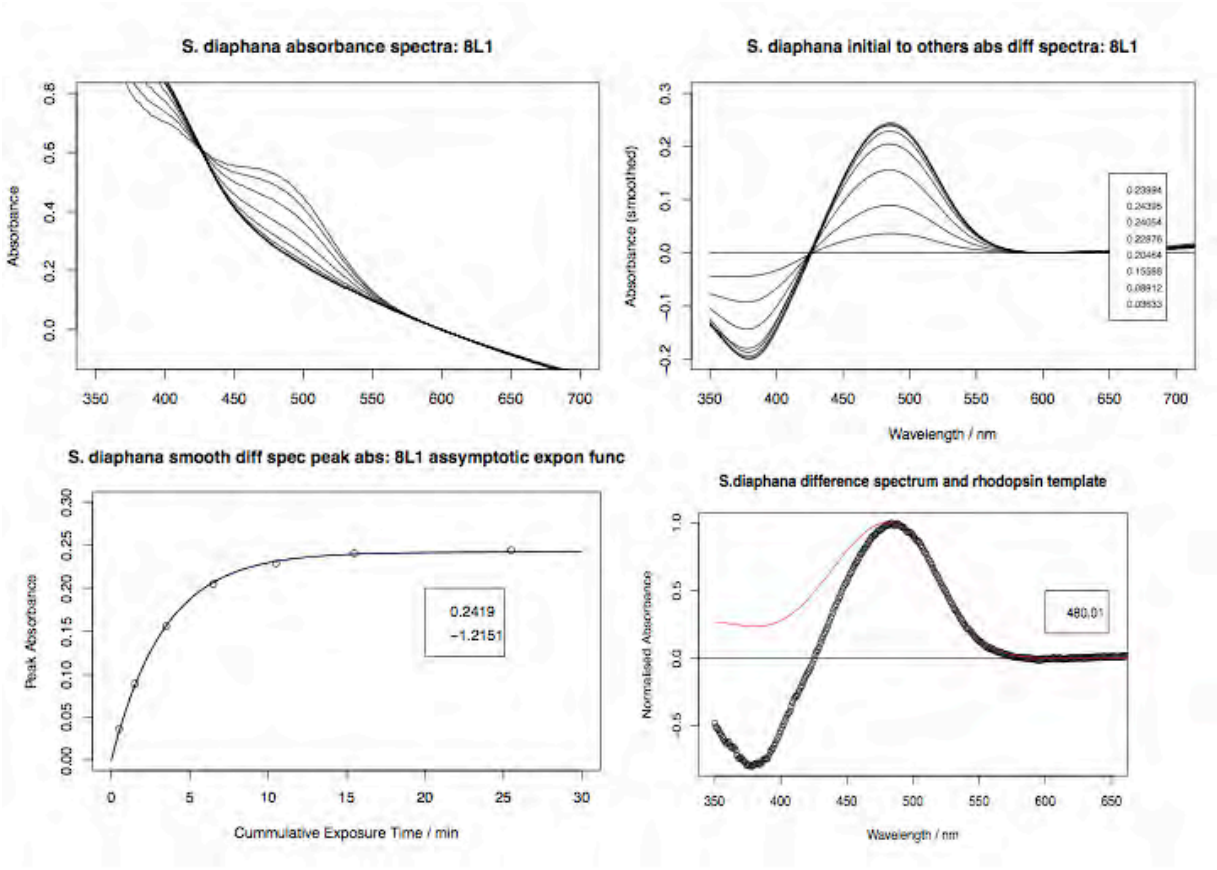


Fig. 7.35: (top left) Absorbance spectral measurements made at sea during R/V SONNE cruise 258 leg 1 of one particular sample - a visual pigment extract from a significantly, but partially, bleached retina of the hatchet fish *Sternoptyx sp.*; (top right) difference spectra between the first and subsequent scans, showing the disappearance of visual pigment (positive-going curves) and the formation of photoproduct (negative going curves) resulting from light exposure; (bottom left) peak Our spectrophotometric approach involved the measurement of the post-mortem rate of regeneration of visual pigment in the retinas of isolated eyes removed from dead deep-sea fish absorbance of the difference spectra plotted against cumulative light exposure, approaching an asymptote value indicative of the total visual pigment concentration in the sample; (bottom right) difference spectrum fitted with a rhodopsin template, showing the λ_{max} to be 480.01 nm in this case (although, note, because of the lack of hydroxylamine in the extract, this apparent λ_{max} may be slightly long-wave shifted by the presence of photoproducts).

Our spectrophotometric approach involved the measurement of the post-mortem rate of regenerationof visual pigment in the retinas of isolated eyes removed from dead deep-sea fish that had been deliberately exposed to light. It has been known since the 1930´s that the regeneration of visual pigment following exposure to light occurs in the isolated eyes of many

'lower' vertebrates (see Marmour and Martin, 1978), as long as the retina is in contact with the RPE, presumably utilizing the store of 11-cis retinal and its precursors located in the RPE. We used this approach to target deep-sea hatchet fish of the genera *Sternoptyx* and *Argyropelecus* to assess their scope for visual pigment regeneration following substantial visual pigment bleaches. Fish caught at night by the University of Queensland team led by Professor Justin Marshall were brought on deck under red light, were dead at the time of catch-sorting and were both sorted and enucleated under dim red light. Pairs of eyes from these fish were exposed to light for controlled periods, causing degrees of visual pigment bleaching. One of the eyes of each pair was immediately put into an opaque container and frozen, the other was placed in darkness, as an isolated eye in buffered saline, in a refrigerator (4°C), to allow the visual pigments to regenerate. At intervals, 'regenerating' retinae were removed and frozen to halt enzymatic and/or diffusion processes.

Spectrophotometric measurements consisted essentially of the comparison of visual pigment concentrations in pairs of 'non-regenerated' and 'regenerated' eyes, and measurements of the concentration of visual pigment in samples as a function of regeneration time, extending over a period of several hours. To assay visual pigment concentrations by spectrophotometry, whole eyes were macerated (in darkness) in buffered saline with maltoside (a detergent) and visual pigments were extracted by vibrating the sample for 2 hours at 4°C in darkness. Extracted visual pigments were separated from the tissue by centrifugation and supernatants were scanned in a Shimadzu UV 2101PC spectrophotometer as in our previous work (e.g. Douglas et al., 1997, 1998). Spectrographic measurements of visual pigment extracts were combined with partial bleaching using 501nm monochromatic light to bleach the visual pigment in steps. Difference spectra from these spectral measurements showed the effect of the sequence of bleaches, from which the λ_{max} of the dominant (or only) visual pigment could be ascertained by visual pigment template-fitting, and the course of bleaching followed by plotting the absorbance spectrum peak value against light exposure (Fig. 7.35). In order to standardize the levels of visual pigment, fish size has to be taken into account and, for this reason, a study of the relationship between visual pigment concentration (and eye size) versus body length in the target hatchet fish species was undertaken. To validate this general method individuals of a species of epipelagic scombroid were also tested whilst at sea. In total, the visual pigments of more than 100 fish were measured by spectrophotometry, involving close to 1,000 spectral recordings. Because of this unprecedented data set, analyses are on-going and far from complete, but very preliminary assessments suggest that deep sea hatchet fish have limited, if any, ability to regenerate their visual pigments in these experimental conditions. This is in line with predictions based on histology and retinal anatomy and, if confirmed by the in-depth analysis of our data and further work, suggests the need for caution in the use of bright artificial lights in the deep sea.

In addition to the above, we collected several non-decapod crustaceans and mesopelagic molluscs, preserving them for microCT studies of their ocular and brain anatomies to be conducted at the University of Western Australia.

7.2.3.6 Stomiid Vision

(J. Partridge, H.-J. Wagner, J. Marshall, F. Cortesi)

The loose-jaw stomiid dragon fish are highly unusual deep-sea fish with the ability to see far-red bioluminescence which they also produce. Unique among them is the species *Malacosteus niger*, which is the only vertebrate known to use a bacteriochlorophyll-based photosensitizer to confer longwave sensitivity (Douglas et al., 1998b). Recent advances in molecular analysis have forced us to abandon our hypothesis, that this bacteriochlorophyll was produced by endosymbiotic bacteria near the retinal pigment epithelial layer (Douglas et al., 2016). The structures in question were already observed by Brauer more that 100 years ago, but turned out to be section artifacts. Therefore we had to conclude that the bacteriochlorophyll was taken up with the diet.

The two other species (*Aristostomias* and *Pachystomias*) are thought to contain long-wavelength-sensitive opsins. However this issue is controversial and requires further molecular work. Unexpectedly, in the area of the Afanasy-Nikitin Seamount we found a number of *Aristostomias* specimens in our trawls and therefore plan a new approach using

the more sensitive transcriptomics technique to settle the dispute. Additionally, we plan to study the retinal organization in light microscopic sections.

7.2.3.7 Tubular Eyes in Mesopelagic Fish: Advantages, Drawbacks, and Ways to Overcome them

(*H.-J. Wagner)*

Most fish have more or less spherical eyes and large fields of view, providing the animals with an ability to see almost all around themselves. Several deep sea fish, however, have "tubular eyes"; essentially normal spherical eyes with the sides removed (by evolution), resulting in a much reduced visual field, subtending *ca*. 50 degrees and usually dorsally directed. The generally accepted explanation is that these animals will be very proficient at seeing silhouettes of potential prey against dim, down-welling sunlight, at the expense, however of being blind to bioluminescence (predators) from the sides and from below. This disadvantage may be compensated by a higher light sensitivity due to a larger pupillary opening, and a higher spatial acuity due to increased photoreceptor and ganglion cell density in the retina. Two families of hatchetfish provide a suitable model to test these hypotheses: Members of the *Sternoptyx* family living predominantly below 500 m have hemispherical, „normal" eyes, whereas *Argyropelican* species live above 500 m (where residual sunlight is brighter) and have upwards-directed tubular eyes. We have collected ca. 50 specimens of each family over a wide range of sizes. By comparing pupil/lens diameter related to eye and body size we shall be able to make a quantitative assessment of the hypothesis that tubular eyes are more sensitive because their larger pupillary opening admits more light to the eye. In addition, retinal structure and cell densities will be analyzed and spatial resolution determined.

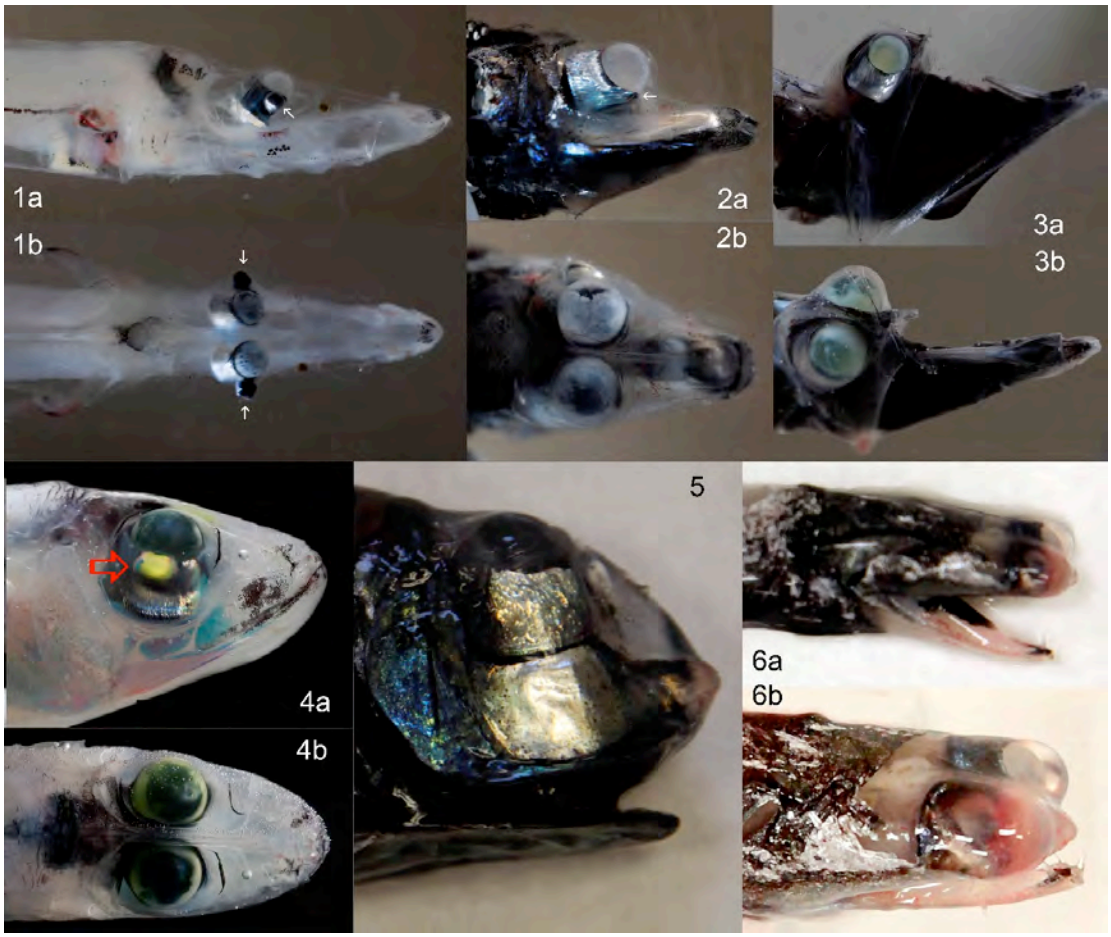


Figure 7.36: Fish with tubular eyes caught on this cruise in lateral (a) and dorsal (b) view; note the orientation of these eyes with respect to the main body axis. 1: *Dolichopteryx longipes* (Arrows indicate the large diverticulum that includes mirror optics); 2: *Winteria telescopa* (Arrow points at small diverticulum); 3: *Stylephorus chordatus*; 4. *Scopelarchus analis* (Open arrow indicates lens pad); 5. *Opisthoproctus soleatus*; 6. *Gigantura indica.* (Photos: 1-4 Wen Sung Chun; 5-6 Ulrich Mattheus)

Interestingly, several deep-sea fish with tubular eyes have „found tricks“ to overcome the obvious disadvantage of a restricted visual field (see Fig. 7.36): Some species like *Dolichopteryx, WInteria* und *Stylephorus* are capable of rotating their eyes by 90°, and thus enlarge their field of view if required. Other species, mainly from the family of barrel eyes (Opisthoproctids) have outpocketings („diverticula“) from the lateral wall of their tube eyes. This family is of particular interest because diverticula in different species present different degrees of complexity ranging from small and simple, to large and complex. Two examples of the latter even have focussing mirror optics which have been described earlier (Wagner et al. 2008; Partridge et al., 2014). It is tempting to speculate about the ontogenetic and phylogenetic processes that have lead to the evolution of these structures. Although most opisthoproctids are very rare we were fortunate on this cruise to obtain apart from several (not so rare) *Opisthoproctus soleatus*, one specimen of *Winteria* and three specimens of *Dolichopteryx*, with possibly more that a single species. These specimens will be examined histologically (light and electron microscopy); in addition, tissue samples have been preserved for transcriptome assays that will help to clarify cladistic relationships in view of a phylogenetic perspective.

Finally, some species like *Scopelarchus, Benthalbella* and *Evermaella* have a lens-pad of highly refractive material at the sclero-corneal junction that might collect light form the side onto the lens and lead to an image on the retina. Here, too the material caught on this cruise will help to clarify the optical role of the lens pad and the resulting light pathways. These will be investigated by light and electron microscopy first, and with these data computer modeling will be attempted to elucidate the optical pathways.

7.2.3.8 Circadian Rhythms in Mesopelagic - Vertical Migrating Fish

(D. Whitmore, I.A.F. Steindal)

As far as we know, most life on earth possess an endogenous and cell autonomous circadian clock. From an evolutionary perspective, this makes a lot of sense, as the onset of day and night, as well as the seasons, is extremely predictable. This endogenous clock controls behaviors such as sleep time, when to eat or hunt, and also cellular processes such as cell cycle and cell division. It is well known that a lot of the mesopelagic wildlife across the globe undergoes daily vertical migrations. This represents the largest daily migration on the planet in terms of biomass and animal numbers. However, to date, there are very few studies looking at the temporal control of this phenomenon. Our aim on this cruise has been to examine clock function at the cell and molecular level in fish species that live mostly in deep ocean environments (in the dark) and which undergo vertical migration. Do they still possess a functional circadian pacemaker? How is this clock set? Does it use light in the standard manner of most organisms? What does the clock control in these animals? How are rhythms in processes such as DNA repair regulated? Experiments on this cruise with focus on mesopelagic species, but a future goal will be to compare these rhythms with those found in deeper, benthic or hadal species.

To address these questions, we chose to examine members of the *Sternoptychidae* family, in particular the deeper living and non-migrating *Sternoptyx* genus (800 - 2,000 m) and the more shallow living and migrating *Argyropelecus hemigymnus* (100 - 700 m). We also took various samples from the *Cyclothone* genus and *Myctophidae* family. Zebrafish tissue (the classical lab model system) is directly light responsive, which means that the fish do not require their eyes or a centralized clock system, such as the suprachiasmatic nucleus (SCN) in mammals, to set the biological clock of each cell in the body. We hypothesize that this direct light sensitivity and clock entrainment is also the case for other teleost species.

In order to determine whether an animal has a circadian core clock or not, and whether it uses the same light entrainable clock mechanism, we will compare gene expression of oscillating clock genes over the course of a day using RT-qPCR. Time points were collected from typically two trawls a day and fish tissues subsequently cultured *in vitro* over the following 4 days. From previous experience, we know that zebrafish organs stay healthy and alive for 5-10 days at 28^{o}C in L15 media. This is also the case for the fish caught and dissected on the SONNE, which appear to survive for many days cultured at 6^{o}C (+/- 0.5). Different tissues were exposed to a variety of light-dark cycles, such as 12 hour light, 12 hour dark (12:12 LD), constant dark and constant light and sampled at 4 times of day. From these experiments we

can determine if the organs can be entrained to a LD cycle, if the organs in constant dark show an endogenous rhythm and if constant light exposure stops the molecular clocks. These samples will be examined back in London/UCL to monitor clock gene expression changes, and also explore novel opsin/photopigment expression patterns. To date, we have now collected more than **500** individual tissue samples under a variety of conditions. This is a remarkable resource/data set, made possible by the efforts of scientist and crew of the SONNE.

Future studies will hopefully expand these studies into species, which live permanently below 1,000 m, and do not undergo vertical migration. The comparison of animals that can experience a rhythmic environment versus those that do not is of considerable interest. These studies will include not only teleost species, but also crustacean and isopods.

7.2.3.9. Sensory Input to the Central Nervous System

(S.P. Collin, T.J. Lisney, C.C. Kerr, H.-J. Wagner)

***Overview and aims**:* Finding food and mates, avoiding predation, social communication and even navigation are all critical behaviors for the large diversity of fishes that live in the mesopelagic or ‚twilight' zone of the world's oceans. The survival of these fishes, therefore, depends on their ability to detect and react to stimuli in their environment, such as any residual downwelling sunlight, bioluminescent light flashes, odors, sound and hydrodynamic disturbances. This study focuses predominantly on the relative importance of different sensory modalities (vision, chemoreception, audition and the lateral line sense) by quantitatively assessing both the number of inputs (nerve axons) conveying information from the peripheral sense organs to the central nervous system, and the relative size of the sensory brain regions that receive input from the peripheral sense organs. This information is important if we are to understand how different species perceive their environment and are adapted for life in the deep-sea. The degree of sensory specialization of key species in the mesopelagic zone (a region occupying a large proportion of our planet) will also help inform us of the ecology and vulnerability of this important fauna to environmental disturbance.

***Methodological approach*:** 324 individuals, representing 61 species from 26 families of mesopelagic and benthopelagic fishes were collected for this study. For some species, a wide range of sizes were also collected, allowing us to track any developmental changes with age (as have been identified in some demersal species; Wagner, 2003). Following capture using a specialized rectangular mesh net trawling between 200m and 1,500, the peripheral sense organs (eyes, olfactory epithelium, taste buds, ears and lateral line) and central nervous systems (brain) of each moribund individual was preserved in 4% paraformaldehyde in 0.1M phosphate buffer. After a period of refrigerated storage, the fixed tissue will be dissected further to fully expose the cranial nerves and brain. Selected cranial nerves, initially CNI – olfactory nerve, and CNII – optic nerve, will be transected and prepared for transmission electron microscopy, where the number of myelinated and unmyelinated axons will be determined using stereology. The size of each sensory brain region will then be assessed using the ellipsoid method (Wagner, 2001a, 2001b; Lisney and Collin, 2006; Lisney et al., 2007; Yopak et a., 2014; Salas et al., 2014, 2015), which is a gross method of comparing the relative contribution or importance' of each sensory modality. This approach will allow a direct comparison to be made between the number of sensory inputs (axons) and the size (volume) of the recipient sensory brain region for both the olfactory and visual systems, although eventually the analysis will be expanded to include other sensory modalities. In order to explore this relationship even further, we will also employ isotropic fractionation (Herculano-Houzel and Lent, 2005; Herculano-Houzel et al. 2005; Yopak, et al. 2014) that will enable us to accurately assess the number of neurons (and possibly synapses) in each brain region, differentiate other non-neuronal cell types (glia, Herculano-Houzel, 2014) and validate our estimates of the size (volume) of each sensory brain region.

Expected findings and impacts: Previous work has revealed that the brains of deep-sea fishes are diverse with respect to the relative size of each sensory brain region (Wagner, 2001a, 2001b; 2002, also see Fig. 7.37). This suggests that each species' reliance on a particular sense differs according to the demands of their lifestyle. The evolution of different sensory strategies among deep-sea fishes may also play an important role in niche-partitioning among mesopelagic fish communities. This study will be the first to compare,

quantitatively, the input from each peripheral sense organ with the neuroanatomical criteria of the size of their recipient brain regions and their neuron number. We expect to reveal high levels of variation in how mesopelagic fishes perceive their dark, three-dimensional environment and more reliably predict the selection pressures driving sensory adaptations and ultimately behavior in the mesopelagic and benthopelagic zones of the deep ocean.

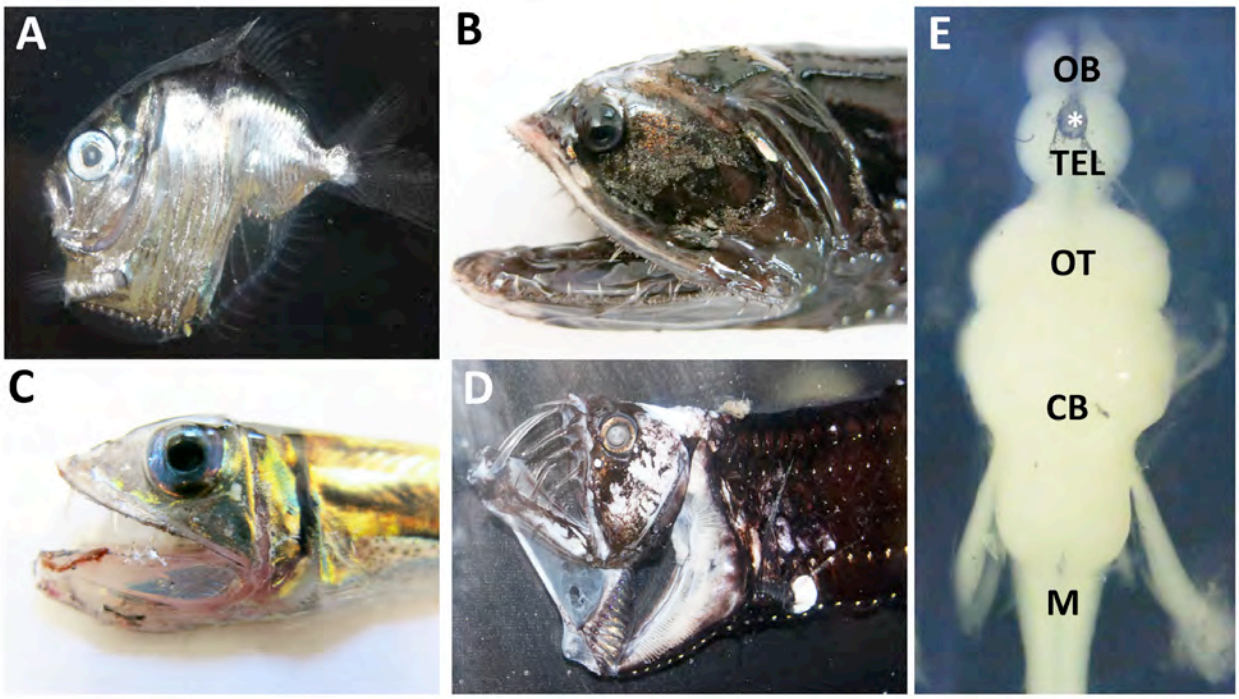


Figure 7.37: A-D. Lateral views of a range of mesopelagic fishes that were examined in this study. A. *Sternoptyx diaphana*. B. *Gonostoma elongatum*. C. *Omosudis lowei*. D. *Chauliodus sloani*. E. Dorsal view of the brain of *G. elongatum* showing the relative size of the different brain regions. CB, cerebellum; OB, olfactory bulbs; M, medulla; TEL, telencephalon. The asterisk indicates the pineal organ. (Photos: Tom Lisney)

7.2.3.10 Lateral Line Ultrastructure and Ecology

(J. Marshall)

This is a long-term project with data input from previous expeditions, including SONNE 194, 209, 234/1 and previous Discovery and Harbour-Branch vessel cruises. The lateral-line vibration detection sense in many deep-sea fish has become pronounced, in part to compensate for a general reduction in visual information. Previous publications have examined the ultrastructure in deep-sea fish such as the gadiform *Melanonus zugmeyeri*, bericiform Melamphaeids and one species of angler fish, *Phrenichthys wedli*. Based on the fish sampled from SONNE 258/1 (Fig. 7.38) and other expeditions, there is now enough data to expand this analysis to 5 other species of angler fish, the iconic deep-sea fish, *Anoplogaster cornuta*, a number of eels including *Saccopharynx pelicanoides, Nemichthys serpentinus, Cyema* along with several whalefish species. Analysis will include mapping of the canal-based and free-standing organs in each species. (double check taxonomic groupings).

Fig. 7.38: Currently unidentified spies of mesopelagic fish collected on this cruise showing distinct pattern of lateral line pores and free-standing organs. (Photo: Wen Sung Chun)

7.2.3.11 The Auditory Abilities of Mesopelagic Fishes

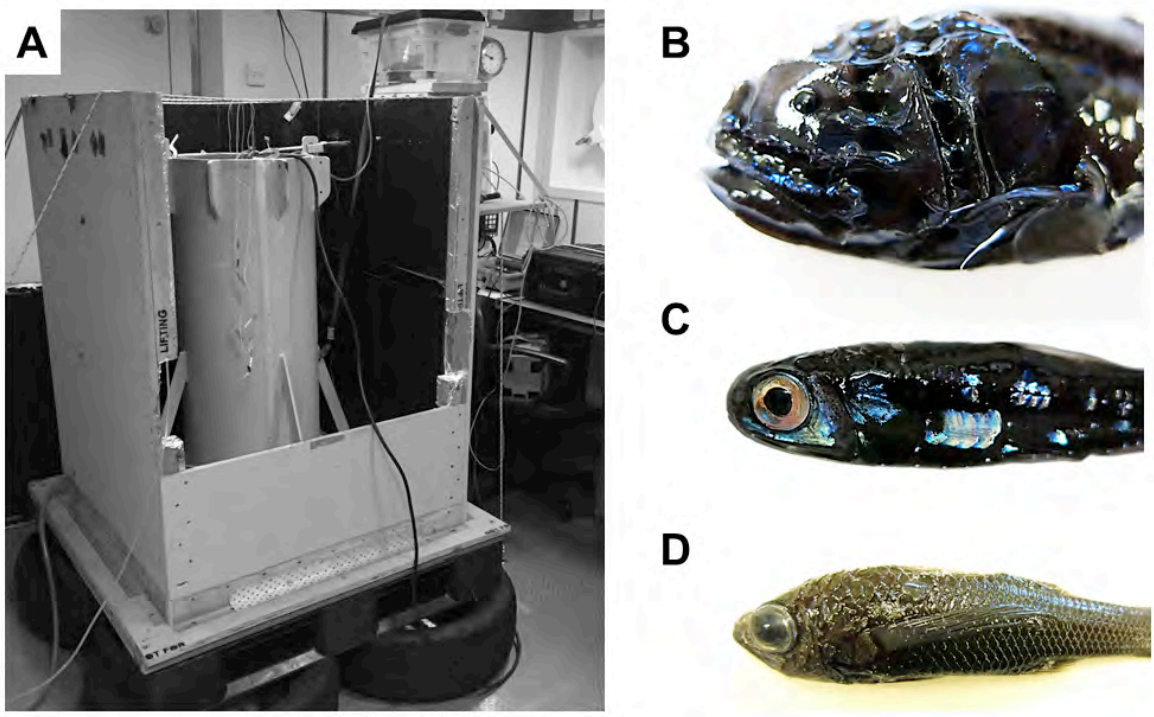
(L. Chapuis, K. Lucke, C.C. Kerr, R. McCauley, S.P. Collin)

Overview and aims: In the deep-sea, sunlight plays only a minor role between 500 and 1,000 m of depth, and is no longer detectable below 1,000 m. Deep-sea fishes living in these environments must overcome darkness, high pressure, low temperature, and scarce food supplies, as well as finding mates despite low population densities. Studies have demonstrated that some deep-sea fishes have evolved highly adapted and sensitive sensory organs to compensate for the lack of light. These adaptations include increased sensitivity in the visual, olfactory, and lateral line systems. However, very little is known about the auditory systems of deep-sea fishes, except for some gross morphology of the ultrastructure of portions of the inner ears in a handful of species (Deng et al. 2011, 2013). Our aims were: (1) to assess the hearing sensitivity of some deep-sea fish species, and (2) to explore the morphological and anatomical specialties of the inner ear of a range of deep-sea species occupying different depths within the water column. While we expect a large variation of inner ear structure similar to other species of fishes (Evangelista et al. 2010, Mills et al. 2011), deep-sea fish species may possess different hearing sensitivities and ear morphologies compared to other species of fishes.

Methodological approach: This study was carried out with the approval of The University of Western Australia Animal Ethics Committee (Application RA/3/100/1532) and in strict accordance with the guidelines of the Australian Code of Practice for the Care and Use of Animals for Scientific Purposes (8th Edition, 2013). The animals used for this study were caught using a specialised rectangular mesh net trawling between 200 m and 1,500 m. Hearing responses were determined for individuals by measuring an auditory evoked potential (AEP) in response to a tonal stimulus at a known sound pressure level (SPL) and particle acceleration level (PAL). Only living individuals were selected for AEP experiments. AEPs were performed on-site on the R/V SONNE in a steel pipe test chamber (Fig. 7.39). An underwater sound transducer was placed at the bottom of the steel pipe, on a sand bed to reduce vibration of the transducer in the chamber. The test chamber was filled with seawater at a temperature between 7˚C and 8˚C throughout testing. Each individual fish was immersed and anaesthetised in a bath of MS-222 (tricaine methanesulfonate). The level of anaesthesia was monitored until the animal reached an early Stage III.1 anaesthesia level, corresponding to a light anaesthesia, suitable for minor surgical procedure. Once anaesthetised, the subject

was transferred to the test chamber and secured in a sling 300 mm below the water surface. Aerated seawater and maintenance anaesthesia was delivered with a gravity-fed flow of water delivered into the mouth and over the gills of the fish via a soft plastic tube. A recording electrode was inserted subdermally into the dorsal surface of the animal, directly over the brainstem. A reference electrode was inserted subdermally anterior to the dorsal fin. A ground electrode was placed directly in the water near the fish. Sound stimuli were produced and AEP waveforms recorded using a data acquisition system controlled by the EVREST software (Finneran 2009). Stimuli were windowed sinusoidal tone bursts of 20ms duration at fundamental frequencies from 100 Hz to 5000 Hz. The SPL of each component was adjusted using the adaptive threshold procedure (Finneran 2009). At the end of the experiment, fishes were euthanised with an overdose of MS-222. The heads (including the ears) were preserved in 4% paraformaldehyde in 0.1M phosphate buffer. Successful recordings were gathered from a total of 19 individuals from 10 species of mesopelagic fishes. After AEP recordings are analyzed, intensity and frequency thresholds will be calculated, resulting in an audiogram for each species. The preserved tissues (along with the ears also collected from Project 7.3.2.9) will be scanned using micro computer tomography (µCT) to investigate the morphology of the ear of each selected species.

Expected findings and impacts: The few studies that focused on the hearing system of deep-sea fishes have all highlighted specialised anatomical structures in the inner ear, plus some interspecific variation (Buran et al. 2005; Deng et al. 2011, 2013). These structures presumably enhance the hearing sensitivity of deep-sea fishes, which may rely more on this modality than shallow water species. The audiograms resulting from our AEP experiments will allow us to strengthen or refute this hypothesis. The morphological examination of the inner ear using three dimensional µCT will explore interspecific variation at a much finer scale and in a greater range of species. Our efforts will be focused on establishing any structure-function relationships linking these anatomical structures with the functional audiograms. This study will be the first to produce audiograms for any deep-sea teleost species and will establish a large dataset of inner ear morphologies, which can be compared to their shallow water counterparts. The data will highlight the importance of sound for the mesopelagic fish fauna and complement Project 7.3.2.9 with respect to the relative importance of hearing in the mesopelagic zone.



Fig, 7.39: A. Steel acoustic chamber used for Auditory Evoked Potential experiments on board the R/V SONNE. B-D. Lateral views of a range of mesopelagic fishes that were examined in this study. B. *Poromitra crassiceps*. C. *Ceratoscopelus warmingii*. D. *Howella sherborni*. (Photo: UWA)

7.2.3.12. Shrimp Spectral Sensitivity

(T. Frank)

The species of particular interest were those that had both photophores and a bioluminescent spew. In the Oplophoridae, those species that possess both have both a near-UV and a blue visual pigment, while those species that possess just a spew have just the blue visual pigment. On this cruise, *Plesionika sp.,* a genus of Pandalidae known to possess both spew and photophores, was studied extensively. Specimens that were retrieved without exposure to light were examined electrophysiologically, using the set-up shown in figure 7.40. The recording chamber contained refrigerated seawater, enabling recordings from live animals lasting up to 8 hours, meaning that dark-adapted and chromatically adapted spectral sensitivity curves could be obtained from the same animal.

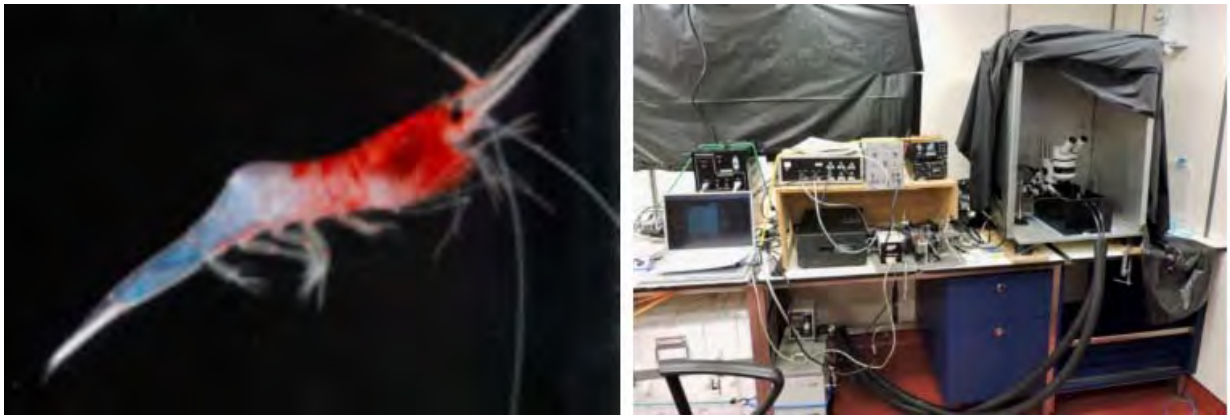


Fig 7.40: left: *Plesionika sp*; right: experimental set-up for stimulation and electrophysiological recordings (Photos: T. Frank)

Both dark-adapted waveform differences in response to near-UV vs. blue light, as well as the effects of chromatic adaptation experiments, demonstrated this this genus (which will be identified to species back in my lab in Florida) also has the dual visual pigment, the first time this has been shown in any deep-sea crustacean species outside of the family Oplophoridae.

In addition to studying photoreceptors, I also recorded from photophores (light producting organs) in the Oplophoridae and Sergestidae, to determine if they showed any evidence of light sensitivity. There were no recordable responses from the lateral or ventral abdominal photophores of Oplophorid species *Janicella spinacauda, Oplophorus gracilirostris* or *Systellaspis* (Fig. 7.41).

Fig. 7.41: Three species of Oplophoridae. (Photos T. Frank)

However, *Sergestes* have a very large photophore called the organ of Pesta (Fig. 7.42), and surprisingly, recordings from the anterior lobe of this photophores demonstrated a light response when eyes were intact, but no response when eyes had been removed. Further testing verified that this was not an echo of the photoreceptor response, or transmission of the response through seawater, as insertion of the electrode into muscle tissue laterally and anteriorally to the organ of Pesta produced no response. This suggests that there is a direct neural connection between the eyes and the photoreceptors, providing a clue as to how these animals are able to so effectively counterilluminate to hide their silhouettes. This will be further

studied in my laboratory using neural dyes, techniques I learned about from the scientist I was sharing space with on this cruise, Wen-Sung Chung.

Fig. 7.42: left: *Sergestes sp.* right: close-up of anterior lobe of organ of Pesta (Photos: Dante Fenolio

7.2.3.13 Visual Ecology and Neuronal Function in Cephalopods

(W.-S. Chun)

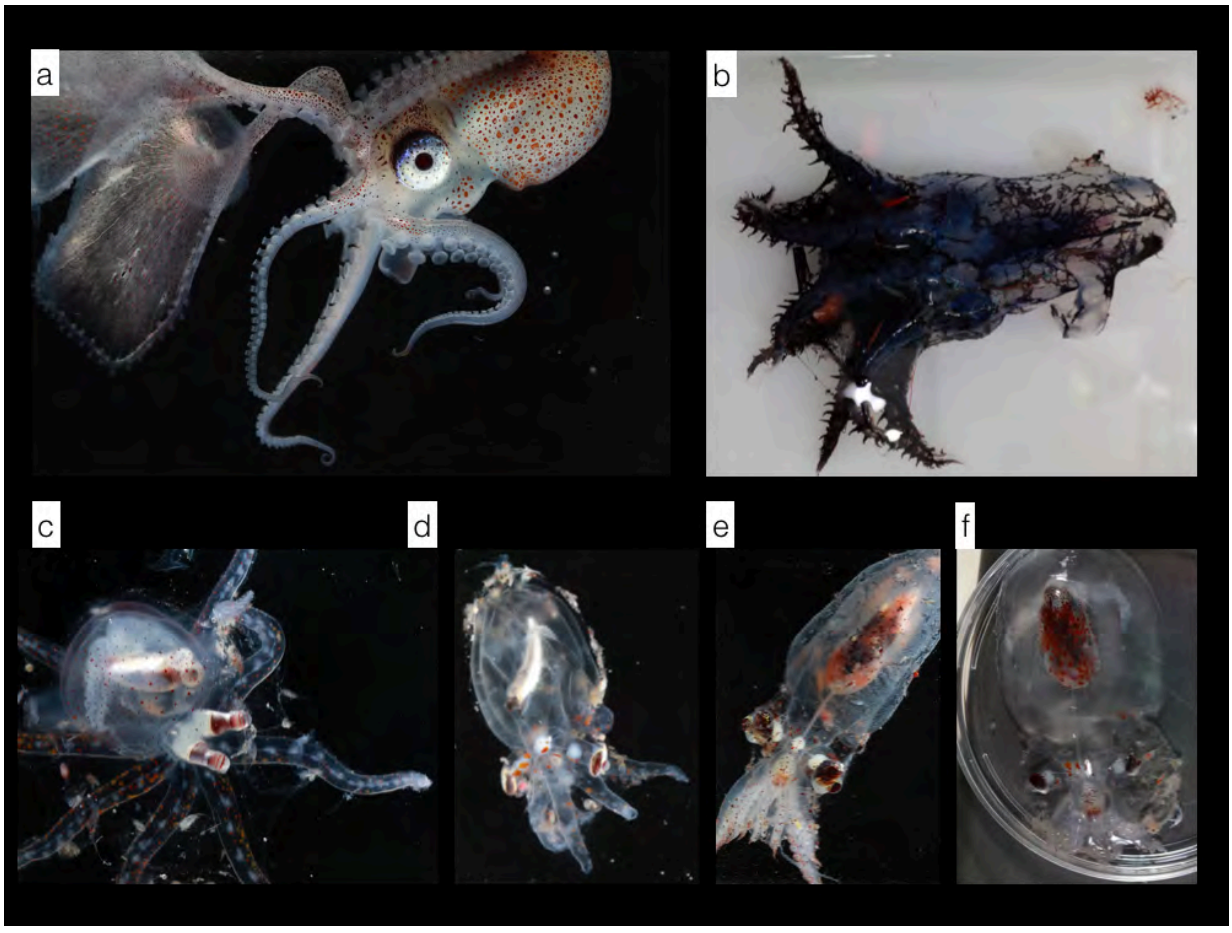


Fig. 7.43: Diversity of octopodiform cephalopods in the south Indian Ocean. a, Paper nautilus (*Argonauta argo*). b, Vampire squid (*Vampyroteuthis infernalis*). c, Telescope octopus (*Amphitretus pelagicus*). d, Glass octopus (*Vitreledonella richardi*). e, Pygmy pelagic octopod (*Bolitaena pygmaea*). f, Diaphanous pelagic octopod (*Japetella diaphana*). (Photos: W.-S. Chun)

The light intensity in the aquatic world is largely determined by two factors, time of day (availability of sunlight) and depth (scattered and absorbed by waters). After dusk, the light level at the surface drops by 8 log units compared to mid-day. Another important feature of underwater light condition is that the intensity of the downwelling sunlight is depth-dependent, with a 10-fold drop in brightness with every 75 m depth increase, even in clear open ocean. In addition, the spectral range is gradually tuned to nearly constant blue spectra over increasing depths. These diverse aquatic photonic environments have driven a variety of visual adaptations across different fauna. Having high sensitivity is one requirement for visual

predators in foraging under the low light conditions and for detecting fast-moving objects. Both fish and cephalopods are fast moving visual predators that live over a great range of depths in the ocean. Cephalopods are attractive for studying the evolution of vision as they have camera-like eyes sharing optical, anatomical and functional characteristics with fish, while having evolved these in parallel through convergence. These adaptations are often linked to the light conditions of their specific niche. In contrast to the extensive investigations of adaptive strategies in fish, vision in response to the varying quantity and quality of available light, our knowledge of visual adaptations in cephalopods remains sparse.

The successful collection of 33 cephalopod species (225 specimens from 17 Families and 27 Genera) between 200 and 1,200 m depth during the cruise of SO258 leg 1 will improve our knowledge of cephalopod diversity in the mesopelagic zone of the Indian Ocean (Fig. 7.43). Our current collection includes several rarely-seen mesopelagic octopuses (e.g. Fig. 7.43 b-e) and squids (e.g. Fig. 7.44 a-c). Also, there is one squid species which is new to science (Fig. 7.44 i).

A large variety of eye shapes and gross brain morphology of cephalopods has been noted (Figs. 7.45 - 7.48). Along with the discovery of these special cephalopod eye designs and brain morphology, histology, magnetic resonance imagery (MRI), diffusion tensor imaging (DTI) and depth distributions will be used to compare brains, eyes, and visual capabilities in order to understand how the squid eye designs reflect the lifestyle and the versatility of neural architecture in its visual system.

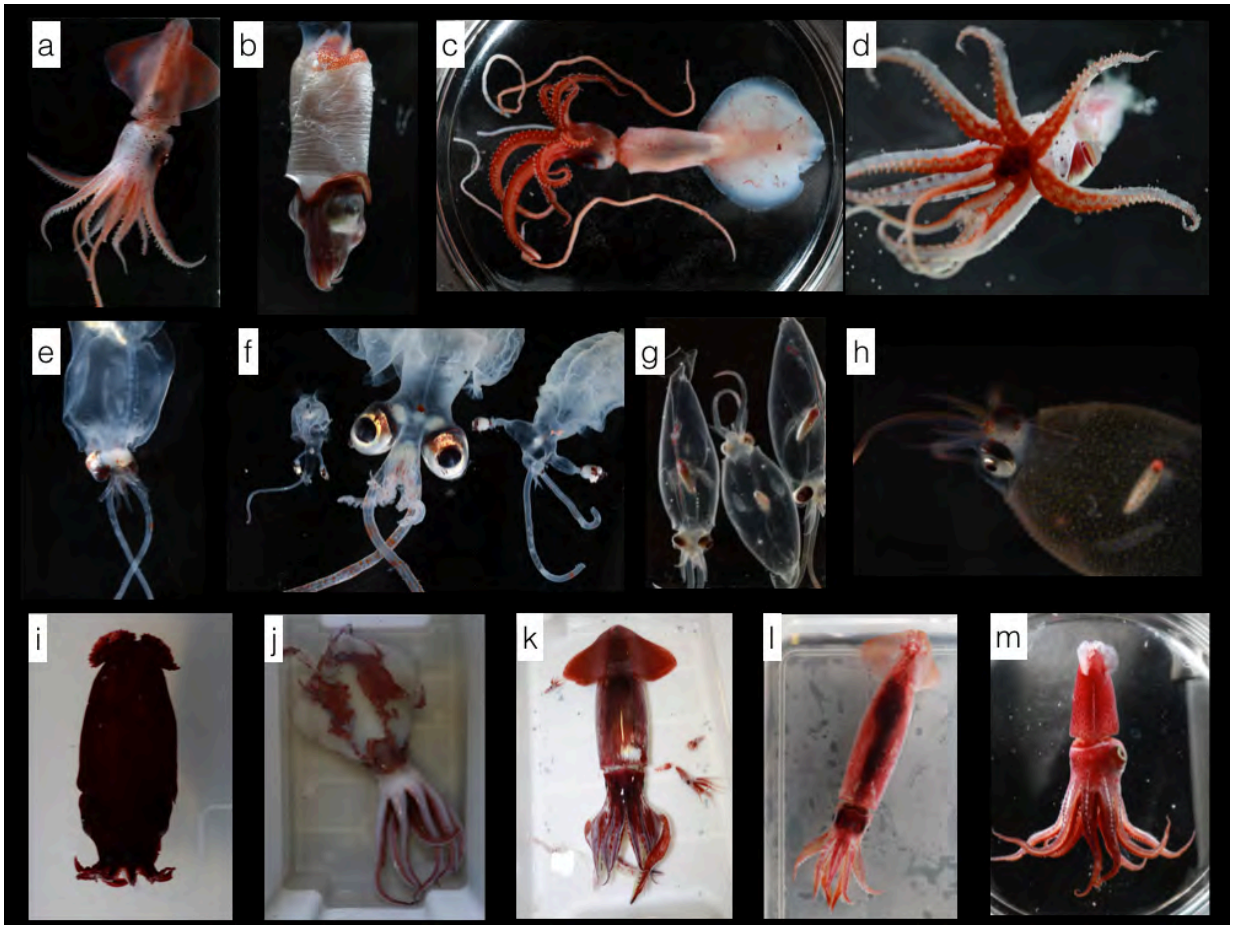


Fig. 7.44: Diversity of decapodiform cephalopods in the south Indian Ocean. a, Sharpear enope squid (*Ancistrocheirus lesueuri*). b, Ram's horn squid (*Spiruala spirula*). c, Whiplash squid (*Mastigoteuthis sp.*). d, Jewel squid (*Histioteuthis hoylei*). e, Melancholicus cranch squid (*Sandalops melancholicus*). f, Lyre cranch squid (*Bathothauma lyromma*). g, *Liocranchia sp.* h, Rough cranch squid (*Cranchia scabra*). i, Bathyal deep-sea squid (*Bathyteuthis sp.*). j, Eight-arm squid (*Octopoteuthis sicula*). k, Purple back squid (*Sthenoteuthis oualanensis*). l, Clubhook squid (*Onychoteuthis sp.*). m, Jewel squid (*Histioteuthis meleagroteuthis*). (Photos: W.-S. Chun)

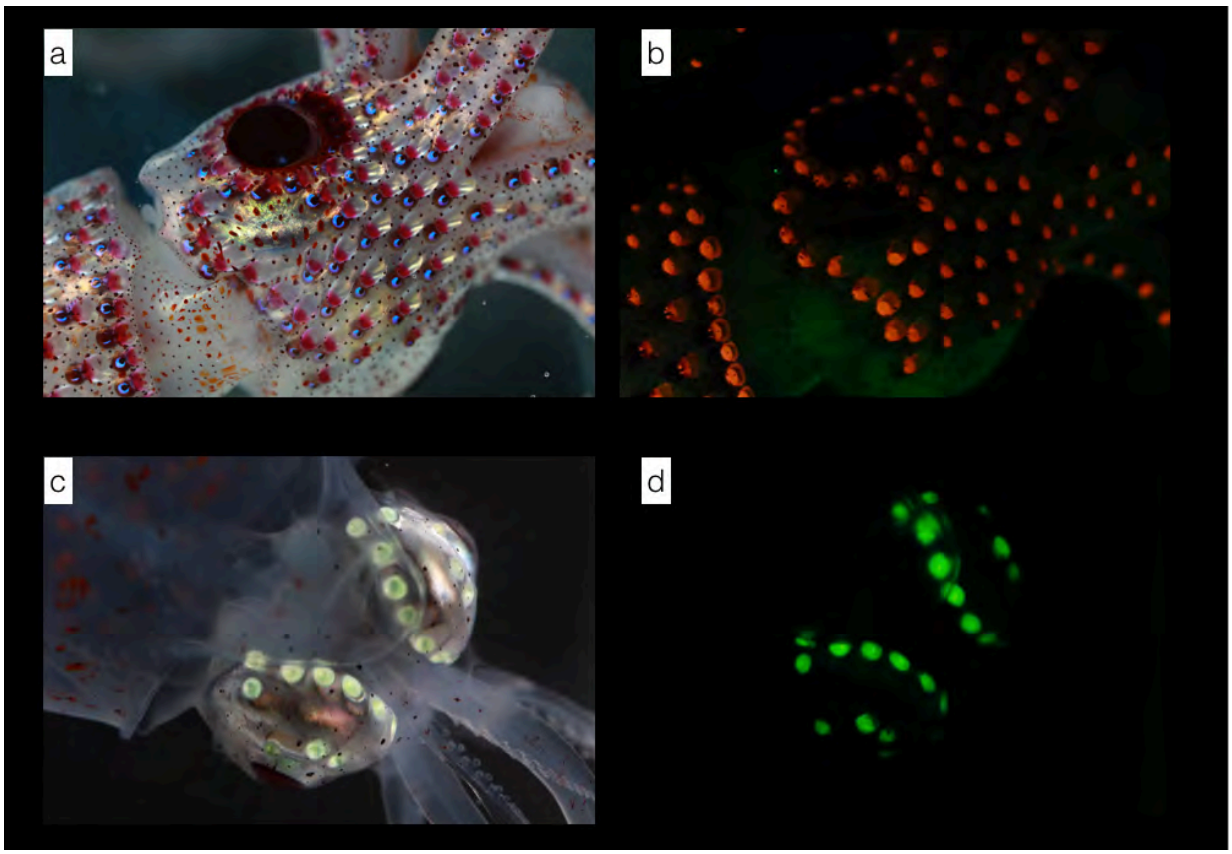


Fig. 7.45: Photophores and fluorescent reflection of squid a-b, *Histioteuthis hoylei.* c-d, *Liocranchia reinhardi.* (Photos: W.-S. Chun)

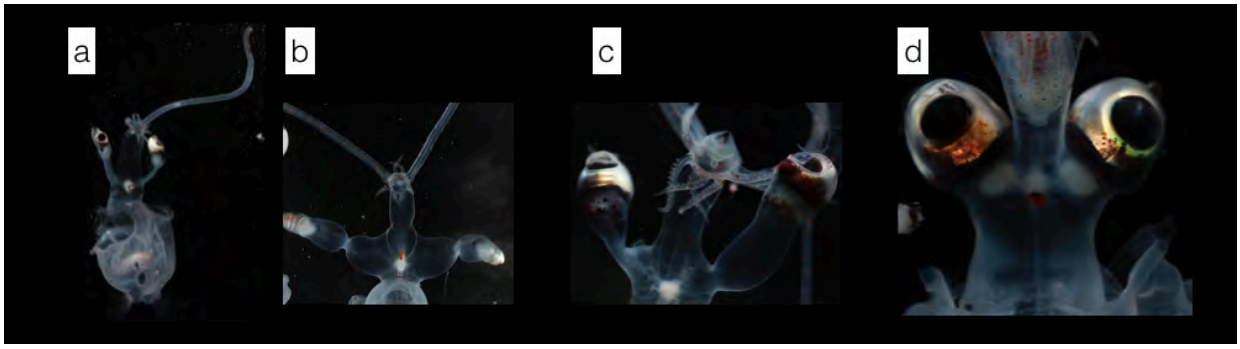


Fig. 7.46: Ontogenetic change of squid eye shape (*Bathothauma lyromma*). (Photos: W.-S. Chun)

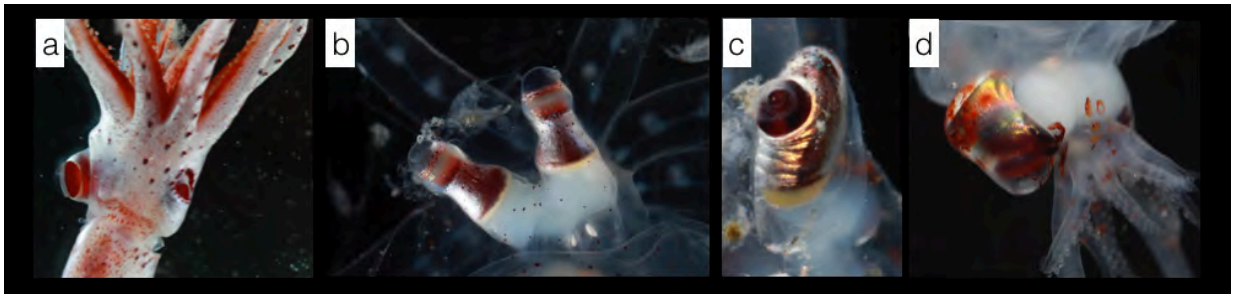


Fig. 7.47: Non-hemispherical eye shape of cephalopods. a, Asymmetric eyes of *Histioteuthis hoylei.* b, Telescope eyes of *Amphitretus pelagicus.* c, Elongated eyes of *Vitredonella richardi.* d, Tubular eyes of *Sandalops melancholicus.* (Photos: W.-S. Chun)

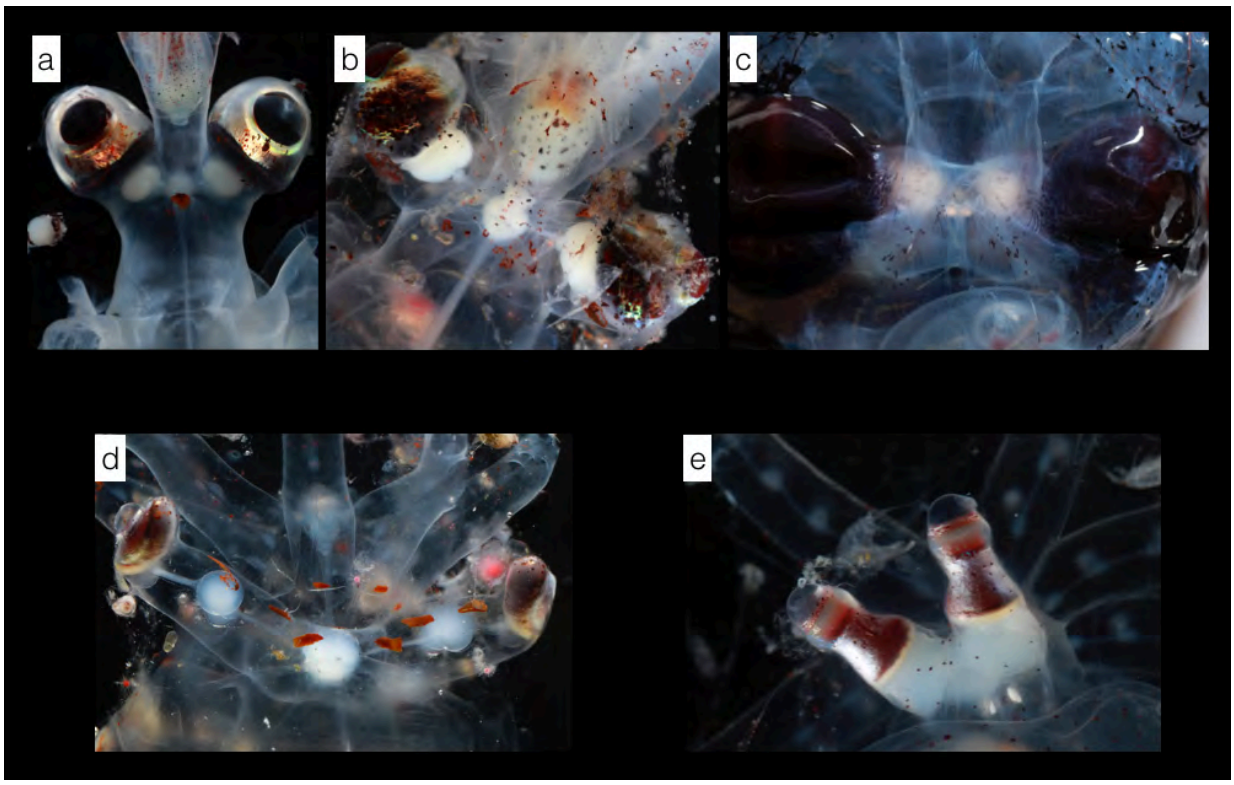


Fig. 7.48: Diverse forms of cephalopod central nervous system. a, *Bathothauma lyromma.* b, *Bolitaena pygmaea.* c, *Vampyroteuthis infernalis.* d, *Vitreledonella richardi.* e, *Amphitretus pelagicus.* (Photos: W.-S. Chun)

7.2.3.14 Free-Falling Autonomous Landers

(A. Jamieson, T. Linley, N. Cuomo)

All animal identifications are preliminary at this stage and are subject to change at a later date.

West Australian Trough – 4,730 - 6,546 m b.s.l.

Seabed images

Imaging deployments at the West Australian Trough revealed a seabed of fine golden sediment with irregular manganese nodules. The mobile fauna observed was typical of abyssal fauna underlying warm surface waters with low productivity (Fig. 7.49).

Amphipods gathered and fed upon the bait, including large *Eurythenes sp.* which were visible in the images. Multiple species of large red penaeid shrimp (some resembling *Plesiopenaeus armatus* (Spence Bate, 1881) were recorded. *Bassozetus* sp. cusk-eels, some greater than a meter in length, were not observed feeding on the bait but would suction feed the gathering amphipods. A single individual of a different cusk-eel species was observed during deployment 11 (Fig. 7.50B).

Fig. 7.49: Deployment 06, Lander 3 at 4,767 m. left: Large red shrimp (cf. *Plesiopenaeus armatus)*, right: *Bassozetus sp.*, amphipods and a brittlestar. (Photo: Newcastle University)

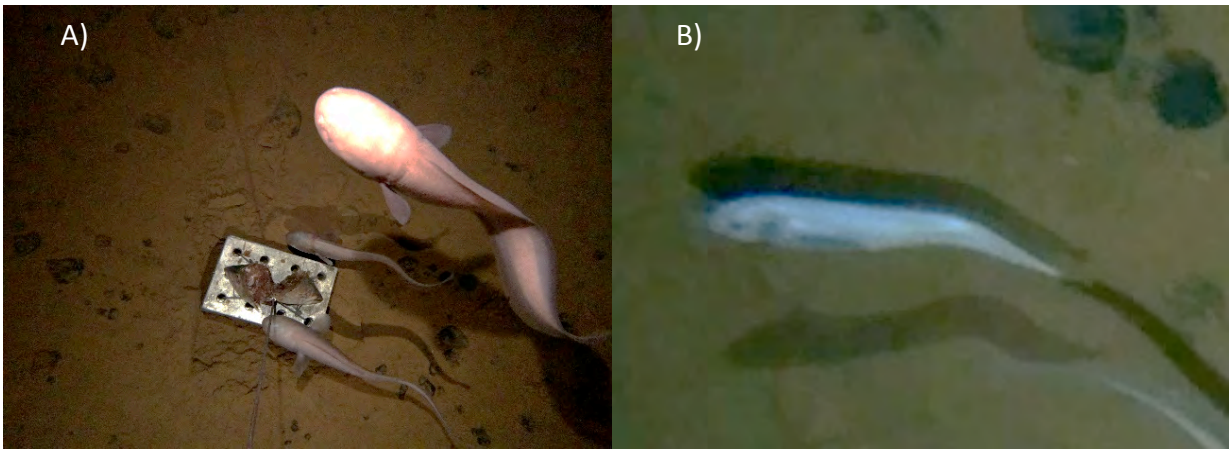


Fig. 7.50: Deployment 11, Lander 3. A) *Bassozetus sp.* as seen at other deployments. B) A second cusk-eel species. (Photo: Newcastle University)

Traps

The trap landers collected large numbers of amphipods, one of the shrimp species and *Bassozetus sp.* (Fig. 7.51).

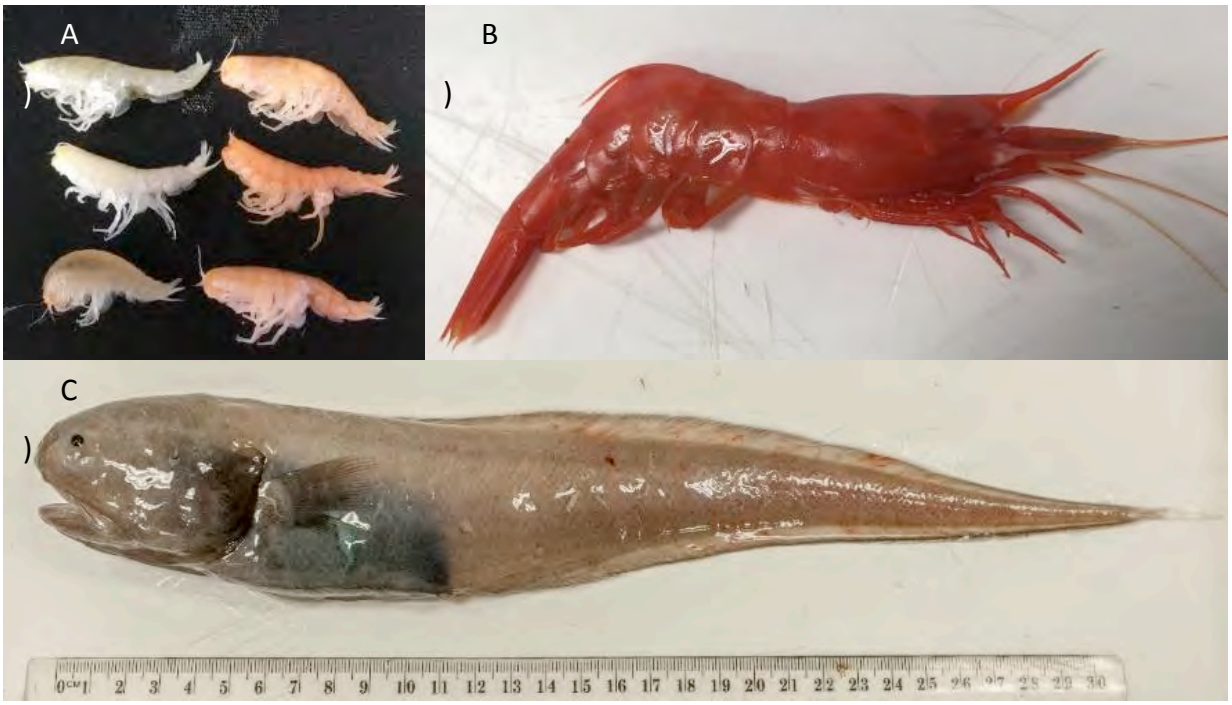


Fig. 7.51: Voucher specimens captured at the West Australian Trough. A) amphipods, B) large red penaeid shrimp, C) *Bassozetus sp.* (Photo: Newcastle University)

Afanasy Nikitin Seamount / Seamount Base

Seabed images

Deployments at the Afanasy Nikitin Seamount base revealed a seabed of poorly sorted golden sand with the occasional manganese nodule. The mobile fauna observed is typical of that underlying warm but more productive surface waters. There was a greater diversity of fish fauna. In addition to the previously seen *Bassozetus sp.* cusk-eels (Fig. 7.50) were two additional species: *Barathrites iris* (Fig. 7.52) and a species which is too small to identify (Fig. 7.52C).

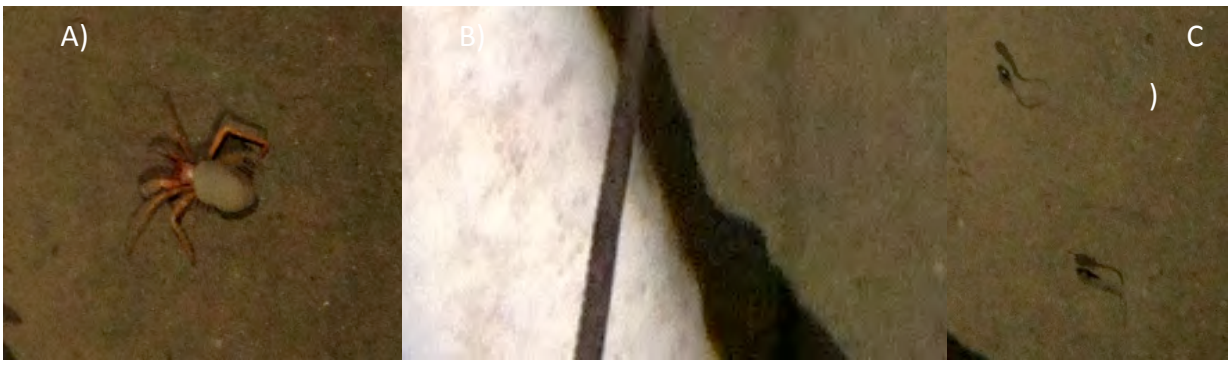


Fig. 7.52: Deployment 12, Lander 3. A) crab with sponge camouflage. B) The cusk eel *Barathrites iris*. C) Small unknown fish species. (Photo: Newcastle University)

Traps

Two fish voucher specimens were captured on deployment 13. A large *B. iris* (Fig. 7.53 top) as observed on the imaging landers (Fig. 7.52B), and what may be a juvenile *B. iris* of *Bassogigas* species (Figure 7.53 bottom). This resembles the species observed on the video at the West Australian Trough (Fig. 7.50B).

Fig. 7.53: Fish specimens captured on deployment 15. Top: *Barathrites iris*, bottom: cf. *Bassogigas sp.* or juvenile *B. iris*. (Photo: Newcastle University)

Afanasy Nikitin Seamount / Seamount Summit

Animals responded to the bait very quickly. The synaphobranchid eel *Diastobranchus capensis* (the basketwork eel) arrived at the bait just 5 min. after arrival at the seabed. A large number of eels attend the bait during the deployment. Variation in eel size, colour and the shape of the pectoral fins indicates that *Histiobranchus australis* is also present later in the deployment (Fig. 7.54).

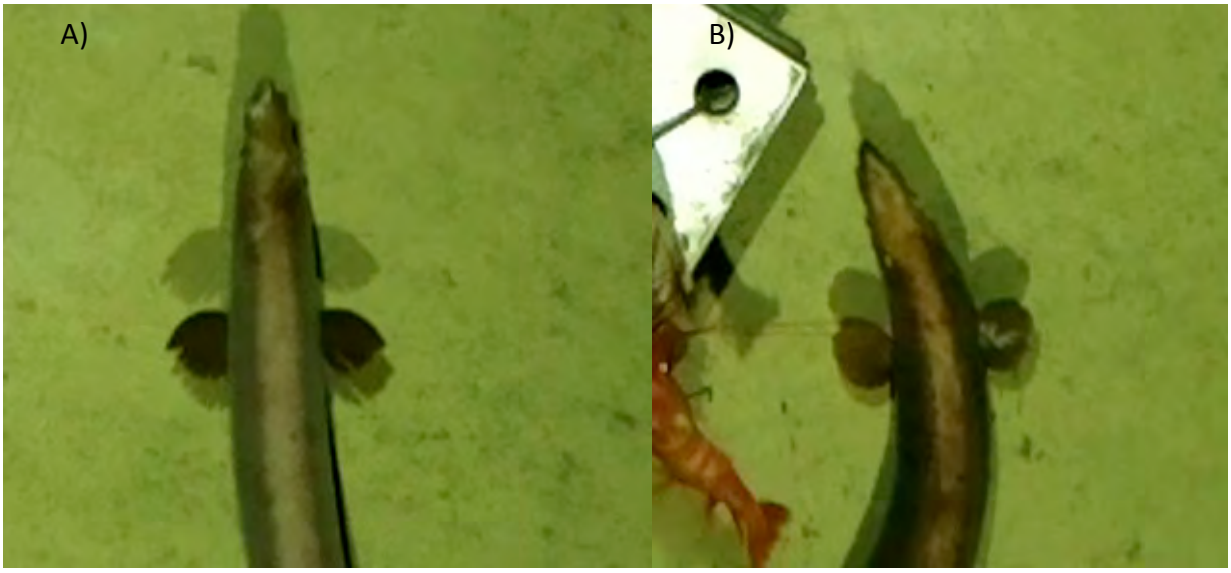


Fig. 7.54: Synaphobranchid eels at deployment 15. A) *Diastobranchus capensis* (tapered pectoral fins), B) *Histiobranchus australis* (rounded pectoral fins). (Photo: Newcastle University)

Additional species were a *Coryphaenoides sp.* rattail (Fig. 7.55A), an unidentified halosaur (Fig. 7.55B), and a very large *Hexanchus griseus* (Bluntnose six gill shark; Fig. 7.56). Large pennaed shrimp and a small number of amphipods were also present.

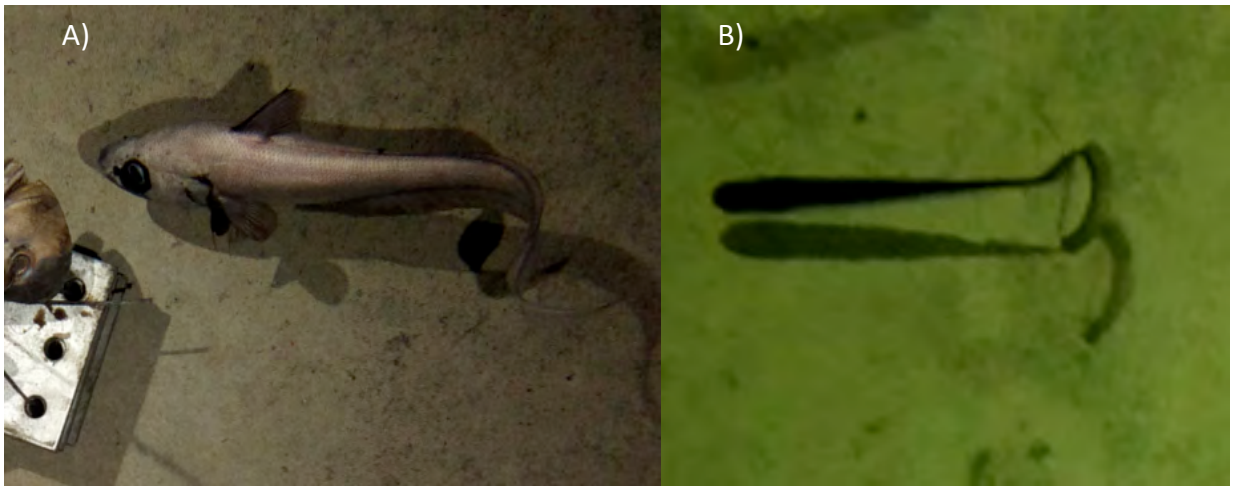


Fig. 7.55: A) *Coryphaenoides sp.*, B) potential halosaur. (Photo: Newcastle University)

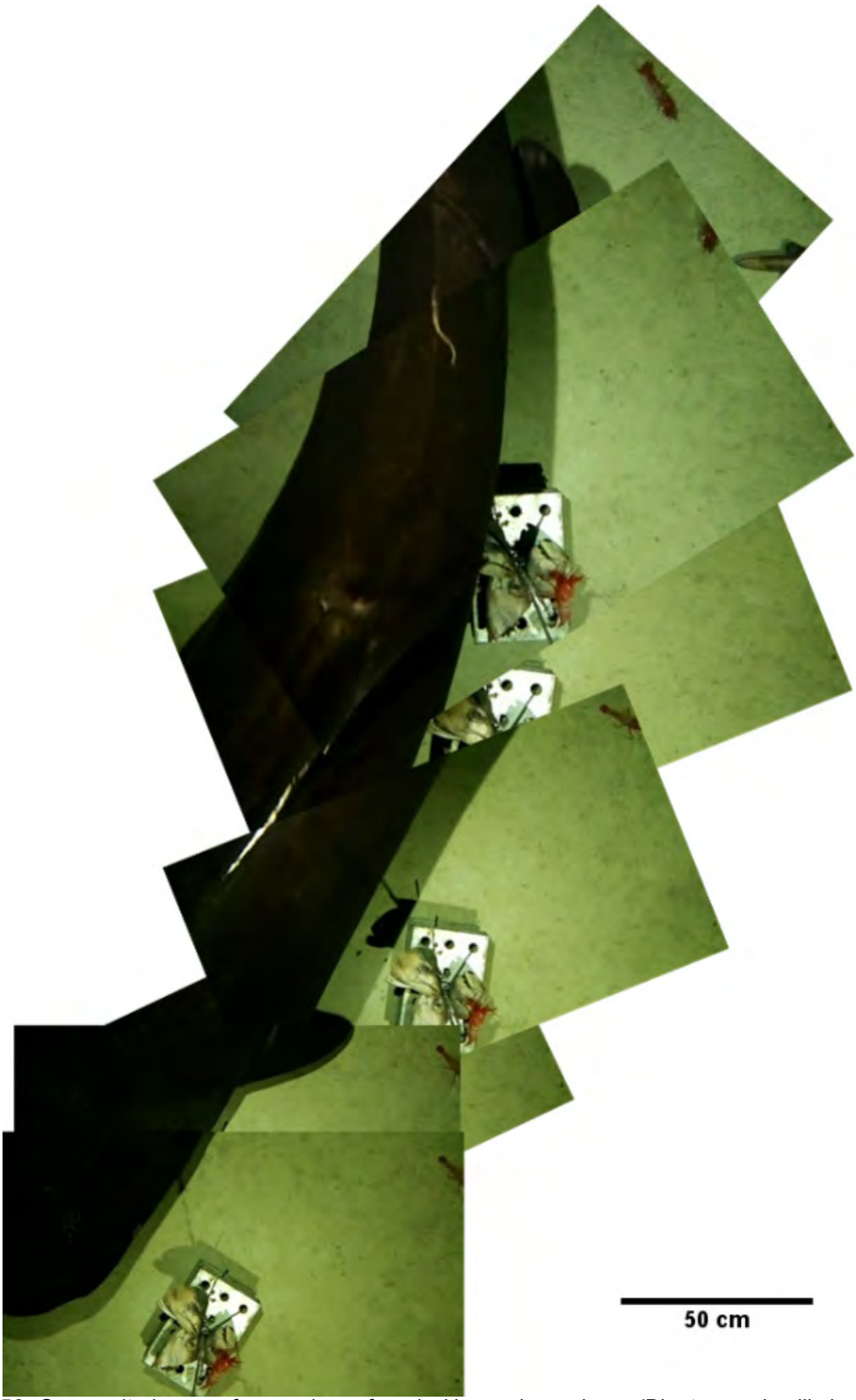


Fig. 7.56: Composite image of a very large female *Hexanchus griseus* (Bluntnose six gill shark).

Appendix I (SO258 Leg 1 Station Summary)

Type	Stat.	Location	total volume	Rec. DR	Station summary	start / on bottom		end / off bottom		depth (m)		Rock sampling			
						lat °N	long °	lat °N	long°	begin	end	Mag	VC	Sed	Mn
T T	1	en route to working area A			*duration of haul: 6.0 hours,1000m, trawl did not open*	-27,143	108,951	-27,026	108,807	5405	5488				
T T	2-1	en route to working area A			duration of haul: 4.0 hours, 700-650-550-500m	-25,115	106,194	-25,052	106,186	4013	2887				
T T	2-2	en route to working area A			duration of haul: 7.0 hours, 700-650-550-500m	-25,041	106,158	-25,085	106,003	2973	3951				
TVL	3 to 7	N-slope of deep trough in working area A			TV-lander transect 1 (launch of 5 lander)	-22,198	102,503	-22,266	102,443	4737	6550				
T T	8	deep trough in working area A			duration of haul: 6.0 hours, 1200-1000-800-600-400-200m	-22,268	102,437	-22,429	102,330	6551	4492				
TVL	9	N-slope of deep trough in working area A			TV-lander transect 1 (recovery of 5 lander)	-22,195	102,506	-22,275	102,451	4687	6549				
T T	10	deep trough in working area A			duration of haul: 4.0 hours, 500-300m	-22,279	102,446	-22,343	102,414	6537	6611				
TVL	11	N-slope of deep trough in working area A			TV-lander transect 2 (launch of 4 lander)	-22,198	102,504	-22,248	102,425	4740	4735				
T T	12	deep trough in working area A			duration of haul: 7.0 hours, 1000-800-600-400m	-22,246	102,424	-22,351	102,340	6542	5964				
TVL	13	N-slope of deep trough in working area A			TV-lander transect 2 (recovery of 4 lander)	-22,196	102,516	-22,249	102,434	4740	6500				
T T	14	deep trough in working area A			duration of haul: 5.5 hours, 400-300-200m	-22,249	102,434	-22,313	102,425	6493	6552				
TVL	15	bottom of deep trough in working area A			TV-lander transect 2 (launch of 2 lander))	-22,249	102,459	-22,246	102,465	6237	6109				
T T	16	deep trough in working area A			duration of haul: 8.5 hours, 1000-800-200m	-22,246	102,465	-22,381	102,401	6101	5967				
TVL	17	bottom of deep trough in working area A			TV-lander transect 2 (recovery of 2 lander)	-22,244	102,461	-22,247	102,471	6103	6091				
T T	18	en route to Osborn Seamount			duration of haul: 5.0 hours, 1200-200-100m	-17,626	91,727	-17,685	91,870	5434	5407				
T T	19	en route to Osborn Seamount			duration of haul: 9.3 hours, 800-200-100m	-17,695	91,893	-17,789	92,116	5586	5407				
T T	20	en route to Osborn Seamount			duration of haul: 3.4 hours, 400-200m	-17,054	90,199	-17,081	90,245	5487	5136				
T T	21	en route to Osborn Seamount			duration of haul: 11.0 hours, 200m	-17,081	90,246	-17,174	90,497	5477	5136				
DR	22	Osborn Seamount	few rocks	1	volcaniclastic rocks	-15,900	86,760	-15,730	86,768	3412	3088		yes		
DR	23	Osborn Seamount	empty	0		-15,633	86,520	-15,625	86,520	3523	3071				
T T	24	Osborn Seamount			duration of haul: 3.3 hours	-15,427	86,439	-15,450	86,491	2740	2970				
T T	25	Osborn Seamount			duration of haul: 4.7 hours	-15,451	86,495	-15,495	86,569	2727	2404				
DR	26	85° Fracture Zone, southern section	few rocks	1	lava fragments, volcaniclastic rocks	-12,127	83,910	-12,127	83,917	3987	3550	yes	yes		
DR	27	85° Fracture Zone, southern section	few rocks	1	lava fragments, intrusive and sedimentary rocks, Mn-crusts	-11,981	83,943	-11,978	83,949	4120	3743	yes		yes	yes
CTD	28	Southern Seamounts			*failed because of technical defect*	-10,776	81,756	-10,776	81,756	4941	4936				
DR	28	Southern Seamounts	few rocks	1	lava fragments	-10,628	81,520	-10,628	81,528	4480	4010	yes			
DR	30	Southern Seamounts	1/4 full	1	lava fragments, semi-consolidated sediment, Mn-crusts	-10,671	81,525	-10,664	81,530	4714	4306	yes		yes	yes
DR	31	Southern Seamounts	one rock	0	one piece of Mn-crust	-10,368	81,508	-10,363	81,511	4959	4501				yes
DR	32	Southern Seamounts	few rocks	1	lava fragments, volcaniclastic rock (punice)	-10,423	81,466	-10,416	81,469	4490	4213	yes	yes		
DR	33	Southern Seamounts	few rocks	1	lava fragments, volcaniclastic rocks	-10,037	81,428	-10,033	81,434	4423	3895	yes	yes		
DR	34	Southern Seamounts	2 rocks	1	*lava fragment, Mn-crust+sediment*	-9,919	81,523	-9,912	81,526	4330	3900	yes			yes
CTD	35	Southern Seamounts			only sound profile for EM122 (2.500 m)	-9,912	81,526	-9,912	81,526	3913	3891				
DR	36	Southern Seamounts	few rocks	1	lava fragments	-9,475	81,493	-9,471	81,497	4300	3950	yes			
DR	37	Southern Seamounts	few rocks	1	lava fragments	-9,002	81,464	-8,997	81,485	4928	4510	yes			
DR	38	Seamount north of Southern Seamounts	few rocks	1	lava fragments, volcaniclastic rocks	-7,755	81,599	-7,756	81,605	4724	4300	yes	yes		
DR	39	Afanasi Nikitin Ridge	1/2 full	1	lava fragments	-5,387	82,902	-5,382	82,906	4957	4545	yes			
DR	40	Afanasi Nikitin Ridge	1/3 full	1	lava fragments, Mn-crusts	-5,026	82,971	-5,022	82,975	4750	4430	yes			yes
DR	41	Afanasi Nikitin Ridge	1/3 full	1	lava fragments	-4,894	82,665	-4,901	82,670	4180	3777	yes			
DR	42	Afanasi Nikitin Ridge	few rocks	0	Mn-nodules	-5,009	82,301	-5,009	82,307	5020	4650				yes
TT	43	Afanasi Nikitin Ridge			duration of haul: 3.3 hours, 400-250m	-5,017	82,295	-5,093	82,356	4997	4607				
TT	44	Afanasi Nikitin Ridge			duration of haul: 4.0 hours, 400-250-150m	-5,095	82,357	-5,211	82,413	4590	4441				

Appendix I (SO258 Leg 1 Station Summary)

Type	Stat.	Location	total volume	Rec. DR	Station summary	start / on bottom lat °N	start / on bottom long °	end / off bottom lat °N	end / off bottom long°	depth (m) begin	depth (m) end	Rock sampling Mag	VC	Sed	Mn
DR	45	Afanasi Nikitin Ridge	1/4 full	1	lava fragments, volcaniclastic rocks	-4,662	82,315	-4,662	82,323	4992	4396	yes	yes		
DR	46	Afanasi Nikitin Ridge	1/4 full	1	lava fragments, volcaniclastic rocks	-4,554	82,378	-4,551	82,383	3740	3340	yes	yes		
TT	47	Afanasi Nikitin Ridge			duration of haul: 2.5 hours, 400-250m	-4,139	82,566	-4,178	82,610	3657	3319				
TT	48	Afanasi Nikitin Ridge			duration of haul: 5.0 hours, 400-250m	-4,179	82,611	-4,253	82,708	3325	3221				
DR	49	Afanasi Nikitin Ridge	few rocks	1	lava fragments, volcaniclastic rocks	-4,179	82,582	-4,178	82,590	3879	3364	yes	yes		
DR	50	Afanasi Nikitin Ridge	few rocks	1	lava fragments, volcaniclastic rocks	-3,780	82,489	-3,777	82,494	4459	4181	yes	yes		
DR	51	Afanasi Nikitin Ridge	empty	0		-3,448	82,359	-3,446	82,365	4939	4527				
DR	52	Afanasi Nikitin Ridge	half full	1	lava fragments, volcaniclastic rocks, carbonate	-3,405	82,524	-3,401	82,529	4325	4050	yes	yes	yes	
DR	53	Afanasi Nikitin Ridge	half full	1	lava fragments, volcaniclastic rocks	-3,143	82,483	-3,142	82,488	4469	4203	yes	yes		
TVL	54	Afanasi Nikitin Ridge			TV-lander transect 4 (launch of 3 lander))	-3,149	82,433	-3,159	82,433	4720	4738				
TT	55	Afanasi Nikitin Ridge			duration of haul: 8.0 hours, 1200-800-150m	-3,159	82,437	-3,379	82,442	4724	4505				
TVL	56	Afanasi Nikitin Ridge			TV-lander transect 4 (recovery of 3 lander)	-3,157	82,436	-3,165	82,428	4725					
TT	57	Afanasi Nikitin Ridge			duration of haul: 3.5 hours, 700-150m	-3,234	83,195	-3,353	83,236	3638	2383				
TT	58	Afanasi Nikitin Ridge			duration of haul: 4.0 hours, 800-150m	-3,367	83,242	-3,475	83,288	2897	4596				
DR	59	Afanasi Nikitin Ridge, guyot	empty	0		-3,358	83,228	-3,352	83,233	2912	2367				
DR	60	Afanasi Nikitin Ridge, guyot	few rocks	1	limestones	-3,348	83,177	-3,341	83,182	3030	2610			yes	
DR	61	Afanasi Nikitin Ridge	few rocks	1	lava fragments, volcaniclastic rocks, semi-consolidated sed.	-3,090	83,277	-3,087	83,284	4370	4070	yes	yes		
TVL	62	Afanasi Nikitin Seamount			TV-lander transect 5 (launch of 3 lander)	-3,037	83,094	-3,030	83,088	1593	1550				
TT	63	Afanasi Nikitin Seamount			duration of haul: 8,7 hours, 1000-300m	-2,963	83,060	-3,165	83,176	3202	3897				
TVL	64	Afanasi Nikitin Seamount			TV-lander transect 5 (recovery of 3 lander)	-3,043	83,100	-3,029	83,088	1662	1554				
DR	65	Afanasi Nikitin Seamount	few rocks	1	lava fragments	-3,046	83,016	-3,050	83,020	2690	2280	yes			
TT	66	Afanasi Nikitin Seamount			duration of haul: 5,4 hours, 1200m (overheating of winch)	-2,997	83,048	-3,108	83,100	2570	3250				
TT	67	Afanasi Nikitin Seamount			duration of haul: 3,1 hours, 200m	-3,108	83,100	-3,177	83,131	3251	3670				
DR	68	Afanasi Nikitin Ridge	full	1	lava fragments, volcaniclastic rocks, Mn-crusts	-2,701	82,826	-2,708	82,813	3077	2637	yes			
DR	69	Afanasi Nikitin Ridge	one bloc	1	lava fragment	-2,643	82,720	-2,643	82,720	3272	2880	yes			
DR	70	Afanasi Nikitin Ridge	few rocks	1	lava fragment, Mn-crust+sediment	-2,415	82,595	-2,421	82,598	4073	3660	yes			
TT	71	en route to working area D (Buried Hills)			duration of haul: 4.0 hours, 800-200m	1,219	85,387	1,198	85,287	4461	4466				
DR	72	85° Fracture Zone, northern section	1/6 full	1	lava fragments	2,119	86,099	2,116	86,091	4073	3777	yes			
DR	73	Buried Hills	few rocks	1	volcaniclastic rocks with Mn-crusts	3,449	84,508	3,440	84,505	4059	3570		yes		
DR	74	Buried Hills	empty	0		3,383	84,523	3,379	84,516	4078	3709				
DR	75	Buried Hills	few rocks	1	lava fragments, volcaniclastic rocks, limestone	3,966	84,966	3,958	84,966	4041	3600	yes	yes	yes	
DR	76	Buried Hills	few rocks	1	lava fragments, volcaniclastic rocks	3,967	84,985	3,963	84,985	3760	3528	yes	yes		
DR	77	Buried Hills	few rocks	1	lava fragments	4,113	85,247	4,109	85,243	3971	3736	yes			
DR	78	Buried Hills	one rock	1	lava fragment, Mn-crust+sediment	4,176	85,236	4,172	85,230	3770	3489	yes			
DR	79	Buried Hills	empty	0	(soft sediments)	4,063	85,671	4,062	85,663	4115	3850				
				32	**dredges yielded magmatic and / or sed. rocks 82,1%)**							**29**	**15**	**5**	**7**
				7	**dredges returned empty or yielded only soft sediment and / or Mn and / or dropstones (17,9%)**										

Dredge Stations (DR): 39
Tucker Trawl Stations (TT): 25
TV-Lander Transects (TVL): 5 Transect
CTD Stations (CTD): 2

Mag: magmatic rocks
VC: volcaniclastic rocks
Sed: sedimentary rocks
Mn: Mn-crusts, - nodules

Appendix 2 (Station Details and Rock Description)

SO258-DR22

Description of Location and Structure: Osborn Seamount, southern flank at termination of NE-SW striking ridge (erosional or volcanic feature?). W-facing slope along mid-section

Dredge on bottom UTC 18/06/17 20:21hrs, lat 15°43.99'S, long 86°45.58'E, depth 3971m

Dredge off bottom UTC 18/06/17 22:49hrs, lat 15°43.81'S, long 86°46.10'E, depth 3088m

total volume: very few rocks

Comments: volcaniclastic rocks, all identical. Abundant brownish clasts in white matrix; probably ash. Some clasts have green palagonite cores. Station provides evidence for volcanic origin of structure. It is however unlikely that useful geochemical information can be obtained.

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR22-1	1. Rock Type: volcaniclastic; matrix supported angular to rounded clasts, ø1mm to 10mm, white matrix does not fizz with HCl ---> ash? 2. Size: 8x7x6cm 3. Shape / Angularity: subrounded to rounded 4. Color of cut surface: white-beige matrix, clasts brownish 5. Texture / Vesicularity: matrix supported clasts 6. Phenocrysts: clast; some have green core (palagonite?) with 1mm black Mn? layer around. Brown clast; unclear whether volcanic or sediment. Some have abundant open vesicles 7. Matrix: white-beige, does not fizz with HCl ---> most likely ash 9. Encrustations: Mn patches <1mm thick 10. Comment: probably a highly altered volcaniclastic consisting of white ash matrix and volcanic fragments	x						half of samples to Moscow	
SO258-DR22-2	1. Rock Type: volcaniclastic, similar to -1 2. Size: 10.5x6x6cm+A36 10. Comment: overall similar to -1							half of samples to Moscow	
SO258-DR22-3	1. Rock Type: additional pieces of volcaniclastic rocks indentical to sample 1 & -2 2. Size: 10.5x6x6cm: 10. Comment: overall similar to -1							one piece to Moscow	

SO258-DR23

Description of Location and Structure: Osborn Seamount, southern margin, lower plateau near base of Osborn seamount

Dredge on bottom UTC 19/06/17 06:09hrs, lat 15°37.96'S, long 86°31.19'E, depth 3523m

Dredge off bottom UTC 19/06/17 07:33hrs, lat 15°37.49'S, long 86°31.22'E, depth 3071m

total volume: empty

Appendix 2 (Station Details and Rock Description)

SO258-DR26

Description of Location and Structure: 84°E Fracture Zone, W-facing slope at the bottom of the slope. Steeper E-slope of FZ could not be dredged due to wind directions

Dredge on bottom UTC 20/06/17 16:32hrs, lat 12°7.64'S, long 83°54.59'E, depth 3987m

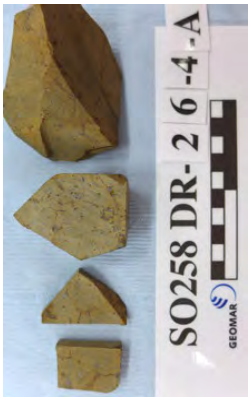
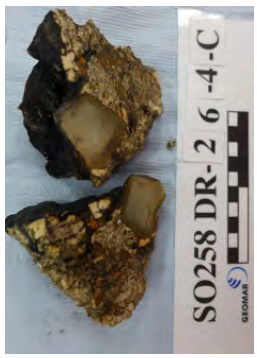
Dredge off bottom UTC 20/06/17 17:47hrs, lat 12°7.64'S, long 83°55.02'E, depth 3550m

total volume: few rocks

Comments: initial observations; crust with possible clasts, some fragments of whitish sediment + three individual angular clasts, probably igneous. Summary: aphyric to slightly phyric lava clasts. -1 to -3 fairly fresh, others very much altered. Ol-Fsp few %, Ol altered, Fsp sometimes fresh. -4D, E and G are clasts of pillow / hyaloclastite contacts that in places contain abundant fresh glass.

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR26-1	1. Rock Type: volcanic; slightly to moderately altered lava clast 2. Size: 8x5x4.5cm 3. Shape / Angularity: subangular 4. Color of cut surface: light grey with to brownish patches 5. Texture / Vesicularity: slightly phyric, <2% Ol-Fsp microphenocrysts; dense groundmass 6. Phenocrysts: Ol, <1% <0.5mm, altered; Fsp, glomerocrystic <<1% ø1mm, fresh 7. Matrix: fine grained, relatively fresh 8. Secondary Minerals: Ol altered to iddingsite 9. Encrustations: slight Mn coating <<1mm 10. Comment: small angular lava clasts, freshest piece of dredge. Angularity indicates short distance of transportation. Basically good for geochemistry and possible dating	x	x					GC in airfreight box	
SO258-DR26-2	1. Rock Type: volcanic; fairly similar to -1, maybe more altered 2. Size: 7x5x4.5cm 3. Shape / Angularity: subangular 4. Color of cut surface: light grey to dark grey, brownish altered patches 5. Texture / Vesicularity: slightly phyric, 3-5% Ol; dense groundmass 6. Phenocrysts: Ol 3-5% ~2mm; Px ~1% <1mm fresh; Fsp 1% ~1mm altered 7. Matrix: bit more coarse grained than -1, relatively fresh 8. Secondary Minerals: Ol altered to iddingsite 9. Encrustations: thin Mn coating ~1mm 10. Comment: maybe fresh Ol in places	x	x						
SO258-DR26-3	1. Rock Type: volcanic; more oxidized than -1 & -2 2. Size: 5x4x3cm 3. Shape / Angularity: subangular 4. Color of cut surface: light brown, beige; some small areas greyish 5. Texture / Vesicularity: slightly phyric; dense groundmass 6. Phenocrysts: Ol 1-2% ~1mm; intergrown Fsp-Px<1% 1-2mm 7. Matrix: fine grained oxidized, Px im matrix 8. Secondary Minerals: iddingsite 10. Comment: still appears suitable for geochemistry, along cracks more altered	x	x						

Appendix 2 (Station Details and Rock Description)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR26-4A	1. Rock Type: volcanic clast from breccia; lava fragment, homogeneously oxidized to light brown, under hand lense grey areas of fresh matrix visible 2. Size: clast 8.5x8x7cm, orignal size of breccia block 40x26x17cm 3. Shape / Angularity: subangular 4. Color of cut surface: beige; partly grey 5. Texture / Vesicularity: slightly phyric, dense, some cracks visible 6. Phenocrysts: Ol 1-2% ~1mm 7. Matrix: fine grained, Fsp + Px in matrix 8. Secondary Minerals: iddingsite 10. Comment: still appears suitable for geochemistry, along cracks more altered	x	x						
SO258-DR26-4B	1. Rock Type: volcanic clast from breccia block; very simlar to -1, bit more altered 2. Size: clast 2.5x3x2cm 3. Shape / Angularity: subangular 4. Color of cut surface: brownish-grey 5. Texture / Vesicularity: aphyric, dense, some cracks visible 6. Phenocrysts: Ol <<1% <1mm 7. Matrix: fine grained 8. Secondary Minerals: iddingsite 10. Comment: small but appears suitable for geochemistry								
SO258-DR26-4C	1. Rock Type: volcanic clast from breccia block 2. Size: clast 4.5x3.5x2cm 3. Shape / Angularity: subangular 4. Color of cut surface: brownish-grey 10. Comment: very similar to -4B								
SO258-DR26-4D	1. Rock Type: volcanic clast from breccia block; altered pillow margins with intrapillow hyaloclastite attached, contains fresh glass 2. Size: 9x8x7cm 3. Shape / Angularity: subangular 4. Color of cut surface: hyaloclastite olive green, lava matrix orange brown, chilled margin dark grey 5. Texture / Vesicularity: lava porphyric, 5% vesicles some open 6. Phenocrysts: Ol ~5% <2mm altered; Fsp+Px ~4% ~2-3mm 7. Matrix: fine grained, mostly oxidized 8. Secondary Minerals: hyaloclastite, mostly palagonite, greenish rounded fragments, some have fresh glassy core 10. Comment: one piece contains a zone with abundant fresh glass, good for EMP and LA-ICPMS	x			GL				

Appendix 2 (Station Details and Rock Description)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR26-4E	1. Rock Type: volcanic clast from breccia block; similar to -4D 2. Size: 15x15x13cm 3. Shape / Angularity: angular 10. Comment: overall indentical to -4D. up to 1cm fresh glass fragments in hyaloclastite	x			GL				
SO258-DR26-4F	1. Rock Type: lava clasts from breccia block; similar to other lava clasts in dredge but strongly brecciated with a lot of fractures cutting across 2. Size: 7x4x5cm 4. Color of cut surface: orange brown some parts light grey 5. Texture / Vesicularity: dense but fractured 6. Phenocrysts: Ol <<1% 10. Comment: similar to -1 but more altered, less phenocrysts								
SO258-DR26-4G	1. Rock Type: lava clasts from breccia block; hyaloclastite very similar to -4D, contains fresh glass 2. Size: 7x6.5x6cm 3. Shape / Angularity: angular 4. Color of cut surface: variable greenish-black-beige / brown 5. Texture / Vesicularity: lava = dense 6. Phenocrysts: Ol oxidized 7. Matrix: larger areas with fresh glass! 10. Comment: fresh glass	x			GL				
SO258-DR26-4H	1. Rock Type: lava clasts from breccia block; strongly brecciated piece of lava. Very simlar to other lava fragments of breccia block -4. In general less Ol 2. Size: 11x8x10cm 7. Matrix: strongly fractured, more oxidized								
SO258-DR26-5	1. Rock Type: three angular lava fragments from breccia block; overall very simlar to other lava fragments of dredge 2. Size: A:3x3x4cm, B: 3x3x3cm, C: 3x2.5x2.5cm 4. Color of cut surface: all light brown with greyish parts 5. Texture / Vesicularity: all phyric, dense 6. Phenocrysts: all Ol microphenocrysts 7. Matrix: A+B with chilled margins	x (A)							

SO258-DR27

Description of Location and Structure: 84°E Fracture Zone, W-facing slope to be dredged due to wind and current directions. SW facing slope of small step.

Dredge on bottom UTC 20/06/17 22:46hrs, lat 11°58.86'S, long 83°56.57'E, depth 4120m

Dredge off bottom UTC 20/06/17 23:57hrs, lat 12°58.66'S, long 83°56.92'E, depth 3743m

total volume: few rocks

Comments: Small fragments of variably phyric Ol-Pl±Cpx basalts. Fragments of pillow lava, two fragments with fresh glass, two small fragments of fully crystalline intrusive rocks of Ol gabbros. Small sample of 4cm thick Mn crust. Summary: In situ samples of basaltic pilow lavas, two fragments of Ol gabbros. All are typical for normal ocean crust

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR27-1	1. Rock Type: volcanic rocks, aphyric basalt 2. Size: 8x8.5x3cm 3. Shape / Angularity: subangular 4. Color of cut surface: yellowish grey 5. Texture / Vesicularity: massive 6. Phenocrysts: rare Ol ~1% 1-2mm 7. Matrix: medium grained, intersertal, fresh Plg, Ol, Px 8. Secondary Minerals: Fe-oxides after Ol, groundmass alteration 9. Encrustations: thin veins filled with Mn-oxides 10. Comment: moderately altered, Plg fresh, Ar-Ar dating of groundmass possible	x	x	3+					
SO258-DR27-2	1. Rock Type: volcanic rocks, Ol-Plg phyric basalt, moderately altered 2. Size: 9x7x4.5cm 3. Shape / Angularity: subangular 4. Color of cut surface: yellowish grey with red and black spots 5. Texture / Vesicularity: massive, porphyric 6. Phenocrysts: Ol 2-3% <1mm; Plg 5-7% <3mm 7. Matrix: fine crystalline, aphanitic 8. Secondary Minerals: Mn oxide spots; Fe oxides after Ol, groundmass alteration 9. Encrustations: thin veins of Mn-oxides 10. Comment: moderately altered ol-Plg phyric basalt, Plg is fresh and good for dating	x	x	2	Plg			GC in airfreight box	
SO258-DR27-3	1. Rock Type: volcanic, altered Ol-Plg phyric basalt with glass rim 2. Size: 5x5x4.5cm 3. Shape / Angularity: subrounded 4. Color of cut surface: gradational from orange to grey, green in outer parts (hyaloclastite) 5. Texture / Vesicularity: massive, porphyric 6. Phenocrysts: Ol, Plg <10% ~0.5mm 7. Matrix: hyalopilitic to aphanitic 8. Secondary Minerals: Fe-oxides, palagonite after glass, Mn veins 9. Encrustations: thin Mn veins 10. Comment: fragment of basalt with hyaloclastite attached. Fresh glass cores in palagonite, needs picking	x	x	2	Plg, GL				

Appendix 2 (Station Details and Rock Description)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR27-4	1. Rock Type: volcanic, aphyric basalt, moderately altered 2. Size: 12.5x5.5x4.5cm 3. Shape / Angularity: angular 4. Color of cut surface: gradation from orange to yellowish brownish grey 5. Texture / Vesicularity: massive, spoty, very rare vesicles <0.5mm 6. Phenocrysts: very rare Ol & Plg 7. Matrix: very fine grained hyalophilitic with elongated Plg laths 8. Secondary Minerals: Fe oxides 9. Encrustations: thin Mn film on outer surface 10. Comment: aphyric basalt, maybe ok for geochemistry, not good for Ar-Ar	x	x						
SO258-DR27-5	1. Rock Type: volcanic, Ol-Plg phyric basalt 2. Size: 9x6.5x4cm 3. Shape / Angularity: subangular 4. Color of cut surface: yellowish grey with red and grey spots 5. Texture / Vesicularity: porphyric, slightly vesicular ~2% voids 6. Phenocrysts: Ol 5-7% ≤1mm altered to Fe oxides; Plg ~5.7% <2mm fresh 7. Matrix: very fine grained, aphanitic texture 8. Secondary Minerals: Fe oxides, palagonite 9. Encrustations: thin Mn film on outer surface 10. Comment: moderately altered Ol-Plg phyric basalt, Plg fresh	x	x	3+					
SO258-DR27-6	1. Rock Type: volcanic, Ol-Plg phyric basalt similar to -5 2. Size: 7.5x6x4.5cm 10. Comment: moderately to strongly altered Ol-Plg phyric basalt, similar to -5, Plg is fresh	x	x	3+					
SO258-DR27-7	1. Rock Type: volcanic, Ol-Plg phyric basalt with glassy margin 2. Size: 11x8x5cm 3. Shape / Angularity: subangular 4. Color of cut surface: brownish grey with red spots and large 3mm grey spots 5. Texture / Vesicularity: massive porphyritic, very rare vesicles 6. Phenocrysts: Ol <1mm ~5-7% altered to Fe-oxide, Plg ~5% two generations large <5mm, small <1-2mm, both fresh 7. Matrix: microcrystalline, aphanitic 8. Secondary Minerals: Fe-oxided, palagonite 9. Encrustations: Mn coating on outer surface, thin veining 10. Comment: Ol-Plg phyric basalt, altered, Plg is fresh, fresh glass (!)	x	x		GL				

Appendix 2 (Station Details and Rock Description)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR27-8	1. Rock Type: volcanic, Ol-Plg phyric basalt 2. Size: 7.5x4.5x4.5cm 3. Shape / Angularity: subrounded 4. Color of cut surface: yellowish grey, spoty 5. Texture / Vesicularity: massive porphyritic with very rare vesicles 6. Phenocrysts: Ol <1mm ~5% altered to Fe-oxide, Plg <2mm ~5% fresh 7. Matrix: medium grained, intersertal 8. Secondary Minerals: Fe-oxides, palagonite in groundmass 9. Encrustations: thin film of Mn coating on outer surface 10. Comment: moderately altered Ol-Plg phyric basalt. Plg and groundmass are fresh, can be used for dating	x	x	3					
SO258-DR27-9	1. Rock Type: volcanic, Ol-Plg-Cpx phyric basalt, moderately altered 2. Size: 10x5x5.5cm 3. Shape / Angularity: subangular 4. Color of cut surface: brownish grey 5. Texture / Vesicularity: porphyritic, massive 6. Phenocrysts: Ol <1.5mm ~3-5% replaced with Fe-oxide, Plg 3-5mm ~10% fresh, Cpx 1-3mm ~2-3% 1-3mm fresh 7. Matrix: medium grained (Ol+Plg+Cpx), intersertal 8. Secondary Minerals: Fe-oxides, palagonite in groundmass 9. Encrustations: very thin Mn film, yellowish mud 10. Comment: moderately altered Ol-Plg-Cpx basalt. Cpx-Plg fresh. Reasonably good for geochemistry and Ar-Ar. Incrustations should be picked	x	x	2					
SO258-DR27-10	1. Rock Type: volcanic, Ol-Plg-Cpx phyric basalt, similar to -8 2. Size: 6x5x3cm: 10. Comment: groundmass looks fresh in some parts and should be good for geochemistry and Ar-Ar dating. Plg is fresh	x	x	2	Plg			see -8	
SO258-DR27-11	1. Rock Type: volcanic rock, Ol-Plg-Cpx phyric basalt, similar to -9 2. Size: 8x5x3cm 10. Comment: similar to -9 in all features but has similar size	x	x		Cpx, Plg			see -9	

Appendix 2 (Station Details and Rock Description)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR27-12	1. Rock Type: volcanic, Ol-Plg-Cpx phyric basalt 2. Size: 9x6.5x3.5cm 10. Comment: similar to -9 but appears to be more fresh with greyish groundmass, Cpx+Ol form segregations up to ø1cm, Ol altered, Cpx+Plg fresh. Should be good for geochemistry and dating of Plg and groundmass	x	x	2	Cpx, Plg			see -9	
SO258-DR27-13	1. Rock Type: volcanic, rare Ol-Plg phyric basalt, slightly altered 2. Size: 5.5x4.5x4.5cm 3. Shape / Angularity: subrounded 4. Color of cut surface: grey with red spots 5. Texture / Vesicularity: massive, porphyritic 6. Phenocrysts: Ol 2-3% <1.5mm replaced with Fe-oxides; ~5% <5mm fresh 7. Matrix: medium to coarse grained, fresh 8. Secondary Minerals: Fe-oxides, minor palagonitization 9. Encrustations: Mn film on outer surface 10. Comment: rare Ol-Plg phyric basalt, groundmass is fresh and good for geochemistry and dating. Probably the freshest rock in dredge	x	x	2+	Plg				
SO258-DR27-14	1. Rock Type: intrusive rock; Ol gabbro slightly altered 2. Size: 7x6.5x3.5cm 3. Shape / Angularity: subangular 4. Color of cut surface: dark greenish grey with red spots 5. Texture / Vesicularity: massive, fully crystallized, medium grained <5mm 8. Secondary Minerals: Fe-oxides after Ol 9. Encrustations: thin Mn film on outer surface 10. Comment: slightly altered Ol gabbro, Cpx+Plg fresh	x	x	2	Cpx, Plg			GC in airfreight box	
SO258-DR27-15	1. Rock Type: intrusive; Ol gabbro slightly altered, similar to -14 2. Size: 8.5x7x4cm 3. Shape / Angularity: subangular 4. Color of cut surface: dark greenish grey with red spots 5. Texture / Vesicularity: massive, fully crystallized, medium grained <5mm 8. Secondary Minerals: Fe-oxides after Ol 9. Encrustations: thin Mn film on outer surface 10. Comment: slightly altered gabbro, good for geochemistry and dating, somewhat less coarse grained than -14	x	2+	2	Cpx, Plg			see -14	

Appendix 2 (Station Details and Rock Description)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR27-16	1. Rock Type: sediment; breccia composed of angular fragments of hyaloclastite and basalt of various types similar to other samples from this dredge. Fragments cemented by Mn-oxides mixed with mudstone 2. Size: 8.5x6.5x4cm								
SO258-DR27-17	1. Rock Type: Mn crust with some basaltic clusts attached + mudstone 2. Size: 8x6x4.5cm 10. Comment: crust is 4cm thick, some layered								
SO258-DR27-18	**Archive samples** A) Ol-Plg phyric basalt B) rare Ol-Plg phyric basalt C) aphyric basalt D) Ol-Plg phyric, vesicular basalt vesicular basalt E) Ol-Plg phyric vesicular basalt F) rare Ol-Plg phyric basalt , altered to red G) rare Ol-Plg phyric basalt H) Ol-Plg phyric basalt Plg ~2-3mm I) Ol-Plg phyric (7-8%) basalt K) Ol-Plg phyric (15%) basalt L) Ol-Plg phyric (<1mm, ~10%) basalt, slightly vesicular M) Ol-Plg phyric (<1mm, ~10% basalt N) Ol-Plg phyric (<1mm, ~5-7%) mod. altered basalt O) rare Ol Plg phyric basalt, altered P) altered hyaloclastite								

Appendix 2 (Station Details and Rock Description)

SO258-DR29

Description of Location and Structure: Southern Seamounts, southernmost cone, W-flank slope beneath small terrace along SW flank

Dredge on bottom UTC 21/06/17 17:33hrs, lat 11°37.67'S, long 81°31.19'E, depth 4480m
Dredge off bottom UTC 21/06/17 18:54hrs, lat 10°37.68'S, long 81°31.65'E, depth 4010m
total volume: very few rocks
Comments: aphyric, moderately altered lava fragments, -1 & -2 with fresh glass in chilled margins

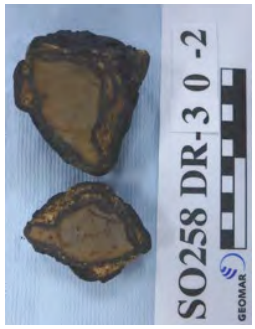
SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR29-1	1. Rock Type: volcanic, aphyric lava, moderately altered, chilled margin with fresh glass 2. Size: 6x5x4cm 3. Shape / Angularity: subangular to rounded 4. Color of cut surface: brownish, some greyish parts, chilled margin 5. Texture / Vesicularity: some to few vesicles 6. Phenocrysts: altered Ol <1% <2mm 7. Matrix: very fine grained, some bright minerals <<1mm 10. Comment: fresh glass crust + chilled margin, along cracks black color Mn?, sometimes appears dendritic	x	x		glassy margin cut off			GC in airfreight box	
SO258-DR29-2	1. Rock Type: volcanic, aphyric lava, moderately altered, a bit less than -1, glass crust , small chilled margin 2. Size: 7x6x4cm 3. Shape / Angularity: subangular to rounded 4. Color of cut surface: greyish with brownish parts 5. Texture / Vesicularity: some small vesicles <<1mm <2%, some filled some not, small fractures across handpiece 7. Matrix: very fine grained, some very bright minerals <<1mm, maybe oxidized Ol (~1mm) or vesicle 10. Comment: glass crust relatively fresh, chilled margin				one slab of glassy margin cut off				
SO258-DR29-3	1. Rock Type: volcanic, aphyric lava, moderately altered 2. Size: 7x5x4.5cm 3. Shape / Angularity: subangular to rounded 4. Color of cut surface: dark grey with brownish patches 5. Texture / Vesicularity: vesicles up to 2mm filled with black material, others are open 7. Matrix: very fine grained 10. Comment: on TS maybe glass	x	x						
SO258-DR29-4	1. Rock Type: volcanic, phyric lava, moderately to strongly altered, Fsp visible 2. Size: 6x5x5cm 3. Shape / Angularity: rounded to subangular 4. Color of cut surface: brownish with black patches 5. Texture / Vesicularity: vesicles (<<1mm) not filled? 6. Phenocrysts: altered Ol ~mm <2%, Fsp needles attached to Ol 7. Matrix: very fine grained 10. Comment: black patches could be Mn infill, in places dendritic along cracks, greenish mineral in few spots Px? secondary?	x	x						

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR29-5	1. Rock Type: volcanic, aphyric lava 2. Size: 5x4x3cm 3. Shape / Angularity: rounded to subangular 4. Color of cut surface: beige with yellowish patches often attached to vesicles 5. Texture / Vesicularity: vesicles <<2mm 2-3%, sporadically filled with black material 7. Matrix: very fine grained, nearly no minerals visible, strongly altered oxidized	x	x						

SO258-DR30

Description of Location and Structure: Southern Seamounts, southernmost cone, 2.5nm S of DR29, repeat station. SW facing slope beneath small cone within the SW-flank of the seamount.

Dredge on bottom UTC 21/06/17 22:30hrs, lat 10°40.25'S, long 81°31.51'E, depth 4714m
Dredge off bottom UTC 22/06/17 00:02hrs, lat 10°39.83'S, long 81°31.77'E, depth 4306m
total volume: 1/4 full
Comments: Mn crusts cementing mudstones, few rocks. Near aphyric to rare Ol phyiric lava fragments (-1 & -2), no glass

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR30-1	1. Rock Type: volcanic, aphyric basalt, moderately altered 2. Size: 6x4x6cm 3. Shape / Angularity: subangular 4. Color of cut surface: dark grey slightly yellowish 5. Texture / Vesicularity: massive with rare Ol phenocrysts 6. Phenocrysts: Ol <1% ~0.5mm replaced with iddingsite (dark green) 7. Matrix: fine to medium grained, intersertal, Plg fresh, Fe-oxide, chlorite 10. Comment: the rock was enclosed / coated within Mn crust; overall seems reasonably good for GC, dating possible	x	x	3+				GC in airfreight box	
SO258-DR30-2	1. Rock Type: volcanic, aphyric basalt, moderately altered 2. Size: 5x3x5cm 3. Shape / Angularity: angular 4. Color of cut surface: grey to yellowish grey (oxidized) 5. Texture / Vesicularity: massive with very rare vesicles, rare Ol phenocrysts 6. Phenocrysts: Ol <<1% ~0.5mm replaced with iddingsite (dark green) 7. Matrix: fine to medium grained, intersertal, Plg fresh 8. Secondary Minerals: oxidation, low T alteration (smectite etc) 10. Comment: the rock was enclosed in ø6cm Mn nodule. Reasonably good for GC, dating possible	x	x	3				GC in airfreight box	
SO258-DR30-3Mn	1. Rock Type: sediment, semi-consolidated mudstone cemented with Mn crust 2. Size: 22x10x9cm 10. Comment: two layers of mud; 1) older pink-yellow soft ~5cm, 2) younger brownish grey ~4cm, fine veining of Mn in all parts. Outer Mn crust 0.5cm								

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR30-4Mn	1. Rock Type: sediment, semi-consolidated mudstone coated with Mn crust 2. Size: 22x7x21cm 10. Comment: pinkish-yellow with numerous Mn encrustations. Worm holes up to ~1cm ø								

SO258-DR31

Description of Location and Structure: Southern Seamounts, 17nm N of DR30 at different seamount. SW facing slope at the base of the seamount.

Dredge on bottom UTC 22/06/17 6:40hrs, lat 10°22.10'S, long 81°30.47'E, depth 4959m
Dredge off bottom UTC 22/06/17 08:00hrs, lat 10°21.76'S, long 81°30.67'E, depth 4501m
total volume: 1 piece of Mn crust
Comments: Mn crust only

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR31-1Mn	1. Rock Type: dense Mn crust 2. Size: 13x7x3cm:								

SO258-DR32

Description of Location and Structure: Southern Seamounts, small caldera volcano ~10nm SW of DR31. Northern inner flank of caldera

Dredge on bottom UTC 22/06/17 12:04hrs, lat 10°25.37'S, long 81°27.98'E, depth 4490m
Dredge off bottom UTC 22/06/17 13:24hrs, lat 10°24.98'S, long 81°28.15'E, depth 4213m
total volume: few rocks
Comments: Angular lava fragments, one piece of pumice. Moderately to strongly altered rare Ol basalt. Sample -1 & -2 are freshest and most suitable for GC. Dating appears less likely.

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR32-1	1. Rock Type: rare Ol phyric lava, moderately altered, largest piece in dredge 2. Size: 16.5x9x7cm 3. Shape / Angularity: angular 4. Color of cut surface: greyish to beige, some light beige patches 5. Texture / Vesicularity: very minor vesicles, near dense, 6. Phenocrysts: oxidized Ol 1-2% , needle like Fsp in groundmass 7. Matrix: fine grained, Ol in groundmass, some light colored needle shaped minerals oxidized 8. Secondary Minerals: alteration along cracks, maybe some greenish material --> fresh Ol??	x	x					GC in airfreight box	

Appendix 2 (Station Details and Rock Description)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR32-2	1. Rock Type: rare Ol phyric lava, moderately altered 2. Size: 9x5.5x6cm 3. Shape / Angularity: angular 4. Color of cut surface: beige to greyish 5. Texture / Vesicularity: cracks cross cuttting, very few vesicles <<1% some filled with black (Mn?) matrial others are open 6. Phenocrysts: oxidized Ol 1-2% <1mm , needle like Fsp in groundmass 7. Matrix: fine grained, Ol in matrix, some light colored needle shaped minerals is probably Fsp, fresh and altered 8. Secondary Minerals: along cracks, maybe some greenish material --> fresh Ol??	x	x						
SO258-DR32-3	1. Rock Type: rare Ol phyric lava, moderately to strongly altered 2. Size: 6x4.5x4cm 3. Shape / Angularity: angular to subangular 4. Color of cut surface: light beige with grey patches 5. Texture / Vesicularity: some very small fractures, vesicles ~1% <<1mm filled with black (Mn?) matrial or empty 6. Phenocrysts: oxidized Ol <1% ~1mm 7. Matrix: fine grained, Ol in matrix, oxidized Fsp (needle shaped mineral) some black minerals (some in good shape, secondary minerals?), oxidized Ol 8. Secondary Minerals: maybe some blackish material 9. Encrustations: Mn crust <1mm	x							
SO258-DR32-4	1. Rock Type: rare Ol phyric lava, strongly altered 2. Size: 7.5x6.5x4cm 3. Shape / Angularity: subangular 4. Color of cut surface: brownish beige 5. Texture / Vesicularity: some vesicles <1% filled with yellow black material 6. Phenocrysts: maybe some oxidized Ol <<1% ~1mm 7. Matrix: very fine grained, abundant altered + fresh needle shaped minerals (Fsp?), few Ol 8. Secondary Minerals: black dendritic Mn along cracks. Whitish material sometimes mineral shaped sometimes in vesicles 9. Encrustations: Mn crust <1mm	x	x						
SO258-DR32-5	1. Rock Type: aphyric lava, strongly altered 2. Size: 6x4x4cm 3. Shape / Angularity: subangular to subangular 4. Color of cut surface: brownish beige with black dendritic-like patches 5. Texture / Vesicularity: vesicles <<1mm <1% open 6. Phenocrysts: oxidized Ol <1% <1mm 7. Matrix: very fine grained, Ol very few, few light needle shaped Fsp mostly altered 8. Secondary Minerals: dendritic Mn 9. Encrustations: Mn crust <1mm	x							

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR32-6	1. Rock Type: pumice, moderately altered 2. Size: 8x7x5.5cm 3. Shape / Angularity: rounded 4. Color of cut surface: light grey 5. Texture / Vesicularity: abundant vesicles <30% up to 10mm open 7. Matrix: foamy 9. Encrustations: maybe a very thin veneer of Mn crust in places 10. Comment: GL to be probed to possibly trace volcanic source	x			GL				

SO258-DR33

Description of Location and Structure: Southern Seamounts, SW flank below top area

Dredge on bottom UTC 22/06/17 20:40hrs, lat 10°2.23'S, long 81°25.65'E, depth 4423m
Dredge off bottom UTC 22/06/17 22:06hrs, lat 10°1.98'S, long 81°26.06'E, depth 3895m
total volume: few rocks
Comments: aphyric lava fragments, a single piece fairly fresh, others moderately to strongly altered, one pillow fragment with fresh glass

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR33-1	1. Rock Type: volcanic, lava fragment with Fsp microphenocrysts, moderately to strongly altered matrix, chilled margin with fresh glass 2. Size: 7x7x5cm 3. Shape / Angularity: subangular 4. Color of cut surface: brown, black to grey chilled margin 5. Texture / Vesicularity: very few vesicles <1% <1mm, mostly open, cracks cutting across 6. Phenocrysts: Fsp microphenocrysts, light colored needle shape, oxidized Ol <1% <1mm 7. Matrix: very fine grained, Ol + Fsp in groundmass, glassy margin 8. Secondary Minerals: Mn lining 10. Comment: chilled margin with fresh glass for spot analysis	x			GL				
SO258-DR33-2	1. Rock Type: volcanic, phyric lava fragment with Fsp & Ol microphenocrysts, moderately altered matrix 2. Size: 5x6x5cm 3. Shape / Angularity: subangular 4. Color of cut surface: mostly grey 5. Texture / Vesicularity: <1% <1mm vesicles, cracks cutting across 6. Phenocrysts: Fsp microphenocrysts, light colored needle shape <1mm <3%, oxidized Ol <3-5% ~1mm 7. Matrix: very fine grained, Ol + Fsp in groundmass, Ol partly oxidized with green areas but this could be secondary chlorite as well 8. Secondary Minerals: chlorite?	x	x					GC in airfreight box	

Appendix 2 (Station Details and Rock Description)

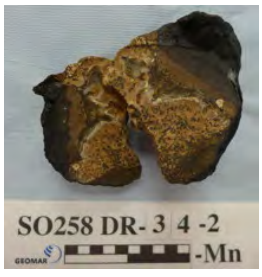
SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR33-3	1. Rock Type: volcanic, phyric lava, moderately altered matrix 2. Size: not measurable too many small pieces 3. Shape / Angularity: subangular 4. Color of cut surface: grey to light grey 5. Texture / Vesicularity: <1% <1mm vesicles, often filled with black material 7. Matrix: very fine grained, possible Ol <1mm <<1%, Fsp? needles and round shaped, few rounded blackish minerals (fillings?)	x	x						
SO258-DR33-4	1. Rock Type: volcanic, aphyric lava, moderately altered 2. Size: 7x6x5cm 3. Shape / Angularity: subangular 4. Color of cut surface: light grey, beige brownish 5. Texture / Vesicularity: <2% <1mm vesicles, empty or filled with yellowish material 7. Matrix: fine grained, light rounded very very small mineral Fsp?, oxidized Ol, black small minerals Px?. Under bino the latter are rather greenish 8. Secondary Minerals: greenish minerals under binocular possibly chlorite 9. Encrustations: Mn crust <<1mm	x	x						
SO258-DR33-5	1. Rock Type: volcanic, slightly phyric lava, moderately altered 2. Size: 11x5x4cm 3. Shape / Angularity: subangular to rounded 4. Color of cut surface: brownish to grey with darker patches 5. Texture / Vesicularity: <1-2% ~1mm vesicles, mostly open some filled with black material 6. Phenocrysts: oxidized Ol <1% ~1mm, Fsp <4mm <<1% white 7. Matrix: fine grained, black parts but no observable minerals, light very small rounded minerals 8. Secondary Minerals: in very few vesicles whitish stuff 9. Encrustations: thin Mn coating <<1mm 10. Comment: Ol + Fsp phenocrysts	x	?						
SO258-DR33-6	1. Rock Type: volcanic, aphyric lava, strongly altered 2. Size: 6x5x4cm 3. Shape / Angularity: subangular to rounded 4. Color of cut surface: brownish with greyish margin 5. Texture / Vesicularity: <2-3% <<1mm vesicles, more common in outer parts of specimen, open 7. Matrix: very fine grained, very small light minerals 8. Secondary Minerals: 10. Comment: chilled margin but no fresh glass								

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR33-7	1. Rock Type: volcanic, pillow fragments in breccia, aphyric, some with glassy margin 2. Size: 19x14x7cm 3. Shape / Angularity: subangular 4. Color of cut surface: some greyish, some brownish, black margins 5. Texture / Vesicularity: <1% <1mm vesicles in lava fragments 6. Phenocrysts: maybe in one fragment 1mm but very altered 7. Matrix: very fine grained, few white Fsp? needles observed 10. Comment: fresh glass in some fragments labelled -7A, 7B, 7C and 7D								

SO258-DR34

Description of Location and Structure: Southern Seamounts, seamount ~10nm north of DR33, southern flank beneath terrace upper half of entire slope

Dredge on bottom UTC 23/06/17 03:22hrs, lat 9°55.11'S, long 81°31.36'E, depth 4330m
Dredge off bottom UTC 22/06/17 04:46hrs, lat 9°54.74'S, long 81°31.53'E, depth 3900m
total volume: two small rocks
Comments: one slightly to moderately altered Plg phyric basalt, one mudstone with Mn crust

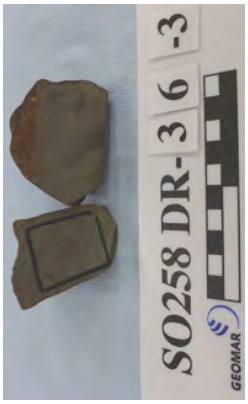
SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR34-1	1. Rock Type: volcanic, Plg-phyric basalt, slightly to moderately altered 2. Size: 7x5x4cm 3. Shape / Angularity: subangular to roundish 4. Color of cut surface: slightly altered, geyish = moderately; brownish = altered 5. Texture / Vesicularity: <1% <1mm, some Cc filled 6. Phenocrysts: Ol <1% 0.5mm, Plg 1% 0.5mm 7. Matrix: fine grained, Cpx (black fresh) in less altered part and red in more altered part, Plg elongated needle form, transparent in color 8. Secondary Minerals: Cc in vesicles, Mn in cracks 10. Comment: small sample but good for geochemistry and dating	x			GL			GC in airfreight box	
SO258-DR34-2	1. Rock Type: sedimentary, semi-consolidated mudstone covered by Mn crust 2. Size: 10x12x12cm 10. Comment: light yellow with numerous Mn encrustations in inner layer. More dense and brown just below Mn crust. ~5cm thick Mn crust forms the top layer. The type of crust is fully analogous to sample DR30-3Mn	x			GL				

SO258-DR36

Description of Location and Structure: Southern Seamounts, small caldera like structure ~30nm north of DR34. Southern outer crater rim, upper part

Dredge on bottom UTC 23/06/17 12:26 hrs, lat 9°28.52'S, long 81°29.59'E, depth 4300m
Dredge off bottom UTC 23/06/17 13:31hrs, lat 9°28.25'S, long 81°29.80'E, depth 3950m
total volume: very few rocks
Comments: angular pillow lava fragments, aphyric with chilled margins that contain fresh glass (-1 & -2). Matrix strongly to moderately altered

Appendix 2 (Station Details and Rock Description)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR36-1	1. Rock Type: volcanic, aphyric lava, moderately altered matrix, maybe fresh glass at margin 2. Size: 5.5x5x4cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey to beige, black margin 5. Texture / Vesicularity: vesicles along margin 2-5% <1mm, internal areas 1-2% <<1mm filled with black white material 6. Phenocrysts: Fsp microphenocrysts whitish, shiny, elongated 7. Matrix: fine grained, light minerals <1mm, dark rounded minerals <<1mm oxidized Ol 8. Secondary Minerals: maybe in vesicles but not obvious, some cracks cutting across 9. Encrustations: glassy margin, mm thick 10. Comment: fresh glass in margin				GL				
SO258-DR36-2	1. Rock Type: volcanic, aphyric lava, with glassy margin 2. Size: 4x4.5x4cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey to browinish 5. Texture / Vesicularity: vesicles <1% <<1mm, cracks filled with black material 7. Matrix: fine grained, very small light minerals, oxidized Ol or secondary minerals, glassy margin 8. Secondary Minerals: maybe in vesicles but could also be oxidized Ol 9. Encrustations: glassy margin 10. Comment: fresh glass	x	x		GL				
SO258-DR36-3	1. Rock Type: volcanic, phyric lava, moderately altered 2. Size: 7x5x2.5cm 3. Shape / Angularity: subangular 4. Color of cut surface: light grey with some darker and brighter patches 5. Texture / Vesicularity:in margin areas with more vesicles than interior ~2% ~1mm some filled with blackish material, all very small 6. Phenocrysts: Fsp microphenocrysts elongated 7. Matrix: fine grained minerals, oxidized Ol, fresh Fsp and Px, all very small 8. Secondary Minerals: maybe in some vesicles greenish Chl?	x	x					GC in airfreight box	
SO258-DR36-4	1. Rock Type: volcanic, phyric lava, moderately to strongly altered 2. Size: 3.5x4x3.5cm 3. Shape / Angularity: subangular 4. Color of cut surface: greyish with brownish patches, margin more brownish 5. Texture / Vesicularity: <1% <<1mm some filled with whitish / yellowisch material 6. Phenocrysts: microphenocrysts ~1mm ~3-5%, oxidized Ol 7. Matrix: very fine grained, Fsp some elongated some rounded, oxidized Ol, black minerals Px?, under binocular greenish parts Chl? 8. Secondary Minerals: maybe Chl?	x	x						

Appendix 2 (Station Details and Rock Description)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR36-5	1. Rock Type: volcanic, aphyric lava, some fresh cores, stronger altered along cracks and margin 2. Size: 11x10x9cm 3. Shape / Angularity: angular 4. Color of cut surface: cores greenish grey, core margin darker grey, margin of rock and along cracks brownish / beige 5. Texture / Vesicularity: dense, many cracks 7. Matrix: fine grained, Fsp needles, light green and dark green minerals = secondary Chl?, dark rounded minerals 8. Secondary Minerals: dark and light green mineral observed	x	x					GC in airfreight box	
SO258-DR36-6	1. Rock Type: volcanic, aphyric lava, moderately and strongly altered 2. Size: 4.5x4.5x2.5cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey to brown altered material red brown 5. Texture / Vesicularity: cracks, vesicles <1mm ~1% filled with whitish material 6. Phenocrysts: oxidized Ol 1mm ~1% microphenocrysts 7. Matrix: very fine grained, Fsp needles elongated to rounded, black mineral, few oxidized Ol 8. Secondary Minerals: along cracks in some vesicles	x	x						
SO258-DR36-7	1. Rock Type: volcanic, aphyric lava, strongly altered 2. Size: 5x4.5x4cm 3. Shape / Angularity: subangular to rounded 4. Color of cut surface: red-brown 5. Texture / Vesicularity: very few vesicles, filled with white material, appears crystallized 7. Matrix: very fine grained and very altered, elongated Fsp needles, greenish mineral 8. Secondary Minerals: mostly in vesicles, maybe also greenish mineral								

SO258-DR37

Description of Location and Structure: Southern Seamounts, northern termination, SW facing slope of large cone from base to mid-section

Dredge on bottom UTC 23/06/17 20:20 hrs, lat 9°0.10'S, long 81°27.82'E, depth 4928m

Dredge off bottom UTC 23/06/17 21:44 hrs, lat 8°59.81'S, long 81°28.10'E, depth 4510m

total volume: very few rocks

Comments: aphyric, angular lava fragments, moderately to strongly altered. -1 has chilled margin with possible fresh glass.

Appendix 2 (Station Details and Rock Description)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR37-1	1. Rock Type: volcanic, aphyric lava, strongly altered, glassy margin? 2. Size: 6.5x5x4.5cm 3. Shape / Angularity: angular to subangular 4. Color of cut surface: reddish-brown with grey patches 5. Texture / Vesicularity: few vesicles <1% <1mm, some filled with black material 6. Phenocrysts: none 7. Matrix: fine crystallized Plg & Px in groundmass 8. Secondary Minerals: cracks cutting through rock, green to black in altered parts of rock 9. Encrustations: Mn crust <1mm 10. Comment: chilled margin with possible fresh glass				GL				
SO258-DR37-2	1. Rock Type: volcanic, aphyric lava, moderatley altered 2. Size: 5.5x4.5x3.5cm 3. Shape / Angularity: subangular 4. Color of cut surface: light grey 5. Texture / Vesicularity: many vesicles 3-5% ~mm, some filled with secondary material, some open 6. Phenocrysts: none 7. Matrix: fine crystallized Plg & Px and altered Ol in groundmass 8. Secondary Minerals: in some vesicles 9. Encrustations: Mn crust <1mm	x	x					GC in airfreight box	
SO258-DR37-3	1. Rock Type: lava fragments from hyaloclastite, moderatley to strongly altered 2. Size: 10x9x6cm 3. Shape / Angularity: rounded with angular to subangular clasts 4. Color of cut surface: red to brown, very few greyish areas 5. Texture / Vesicularity: cracks cutting across rock, dendritic Mn, ~2% <1mm vesicles in lava fragments, some filled with yellowish material 6. Phenocrysts: none 7. Matrix: very fine crystallized, Plg elongated and rounded 9. Encrustations: Mn crust	x	x					GC in airfreight box	
SO258-DR37-4	1. Rock Type: volcanic, aphyric lava, strongly altered 2. Size: 4.5x3.5x3cm 3. Shape / Angularity: angular to subangular 4. Color of cut surface: red to brown, very few greyish areas 5. Texture / Vesicularity: very few vesicles <1% <<1mm 6. Phenocrysts: Ol <1% <3mm 7. Matrix: very fine crystallized Plg and altered Ol in groundmass 9. Encrustations: Mn crust								

SO258-DR38

Description of Location and Structure: Seamount between Southern Seamounts and Afanasy Nikitin. Upper Eastern slope beneath plateau like top

Dredge on bottom UTC 24/06/17 07:30 hrs, lat 7°45.30'S, long 81°35.96'E, depth 4724m
Dredge off bottom UTC 24/06/17 08:42 hrs, lat 7°45.32'S, long 81°36.32'E, depth 4300m
total volume: very few rocks

Comments: mostly Mn nodules up to 15cm ø. -1 is a single, very altered aphyric basalt fragment recovered from Mn crust

Appendix 2 (Station Details and Rock Description)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR38-1	1. Rock Type: volcanic, aphyric lava, very altered 2. Size: 3x3x2cm 3. Shape / Angularity: rounded 4. Color of cut surface: light brown to orange 5. Texture / Vesicularity: <1% vesicles 6. Phenocrysts: Ol <1% <3mm 7. Matrix: fine grained, Plg-Ol 8. Secondary Minerals: Mn patches and veins 9. Encrustations: Mn crust	x	x						
SO258-DR38-2	1. Rock Type: volcanic, altered hyaloclastite with Mn crust and silica vein, glass fragments 2. Size: 9x7x4cm 3. Shape / Angularity: rounded 4. Color of cut surface: Mn black, altered glass green 5. Texture / Vesicularity: none 8. Secondary Minerals: silica vein 9. Encrustations: Mn crust 1cm 10. Comment: sample taken to search for possible fresh glass fragments				GL?				
SO258-DR38-3	1. Rock Type: sedimentary rock with volcanic fragments and Mn crust 2. Size: 15x9x8cm 3. Shape / Angularity: rounded 4. Color of cut surface: Mn black, greyish to brownish to blackish matrix 5. Texture / Vesicularity: fine grained with volcanic fragements <1% vesicles 7. Matrix: fine grained 9. Encrustations: Mn crust 1cm								
SO258-DR38-4	1. Rock Type: volcanic, altered hyaloclastite coated with Mn crust 2. Size: 7x4x6cm 3. Shape / Angularity: rounded 4. Color of cut surface: Mn black, altered glass green, matrix whitish 5. Texture / Vesicularity: <1% vesicles to none 7. Matrix: fine grained no minerals 9. Encrustations: Mn crust 1cm								

SO258-DR39

Description of Location and Structure: Afanasy Nikitin, southern part. S facing slope of E-W striking abyssal hill(?) at the southern tip of Afanasy Nikitin complex

Dredge on bottom UTC 25/06/17 05:13 hrs, lat 5°23.21'S, long 82°54.10'E, depth 4957m
Dredge off bottom UTC 25/06/17 06:35 hrs, lat 5°22.91'S, long 81°54.37'E, depth 4545m
total volume: 1/2 full
Comments: Numerous fragments of pillow lavas with quenched glassy margins, some massive lava sheets(?). Max block size ø 40cm. Three petrographic types distinguished. 1) rare Ol phyric basalts, 2) Ol-Plg phyric basalts, 3) aphyric basalts. Common chilled margins with fresh glass.

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR39-1	1. Rock Type: volcanic, rare Ol phyric basalt, slightly to moderately altered. Part of block A 2. Size: 30x18x14cm original size block A 3. Shape / Angularity: angular 4. Color of cut surface: dark grey, yellowish in some parts 5. Texture / Vesicularity: medium grained, massive with rare phenocrysts, dense 6. Phenocrysts: Ol <2% <1mm altered to Fe oxides, iddingsite 7. Matrix: medium grained, intersertal, Px oxidized, Plg seems fresh 8. Secondary Minerals: alteration halo has yellowish grey color, some veins filled with Mn-oxide, some veins contain blueish green mineral -possible Cu-oxides, also Cc 10. Comment: sample is good for GC and dating appears possible	x	x	~2				GC in airfreight box	
SO258-DR39-2	1. Rock Type: volcanic, rare Ol phyric basalt, slightly to moderately altered. Similar to -1 2. Size: 12x12x8cm	x	x	~2				see -1	
SO258-DR39-3	1. Rock Type: volcanic, Ol-Plg phyric basalt, slightly to moderately altered 2. Size: 15.5x10x8cm 3. Shape / Angularity: angular 4. Color of cut surface: dark grey with white and black spots 5. Texture / Vesicularity: massive, porphyritic, few vesicles filled with Mn 6. Phenocrysts: Plg 10% up to 3mm mostly 1mm fresh; Ol<0.5mm 2-3% in intergrowth with Plg, altered 7. Matrix: fine grained, fresh Plg, Chl after glass, Cpx maybe be chloritized too 8. Secondary Minerals: some chlorification, Mn fillings in vesicles 9. Encrustations: Mn coating on outer surface, oxidation 10. Comment: the rock is somewhat altered but seems good for GC. Black Mn fillings in voids should be avoided when possible	x	x					GC in airfreight box	
SO258-DR39-4	1. Rock Type: volcanic, Plg phyric basalt, moderately altered 2. Size: 11x10x8cm 3. Shape / Angularity: angular 4. Color of cut surface: grey with some brownish parts 5. Texture / Vesicularity: massive, vesicles ~1mm <3-5% filled with Mn 6. Phenocrysts: microphenocrysts of Plg 10% 1mm fresh 7. Matrix: fine grained, mostly fresh Plg 8. Secondary Minerals: some greenish material = Chl 9. Encrustations: Mn crust 1mm	x	x						

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR39-5	1. Rock Type: volcanic, Plg phyric basalt, moderately altered, glassy margin 2. Size: 17.7x10x5cm 3. Shape / Angularity: angular 4. Color of cut surface: grey to light grey 5. Texture / Vesicularity: massive, vesicles <2mm 1-2% mostly filled with Mn, FeOH 6. Phenocrysts: microphenocrysts of Plg 7% <1mm fresh 7. Matrix: fine grained, Plg fresh?	x	x		GL				
SO258-DR39-6	1. Rock Type: volcanic, Plg phyric basalt, moderately altered, glassy margin 2. Size: 15x12x8cm 3. Shape / Angularity: subangular 4. Color of cut surface: dark grey to light grey 5. Texture / Vesicularity: massive, more vesicles <2mm 7% mostly filled with Mn, FeOH 6. Phenocrysts: microphenocrysts of Plg 7% <1mm fresh 7. Matrix: fine grained, Plg appears fresh, very few oxidized Ol, black mineral or filled vesicle?	x	x		GL				
SO258-DR39-7	1. Rock Type: volcanic, Plg phyric basalt, more altered than -4 to -6, but still moderately altered along margins, fresh glass? 2. Size: 23x18x11cm 3. Shape / Angularity: angular 4. Color of cut surface: grey, brownish oxidation halo along margin 5mm 5. Texture / Vesicularity: massive, vesicles filled with Mn, FeOH greenish secondary mineral Chl? 6. Phenocrysts: microphenocrysts of Plg 5-7% <1mm fresh 7. Matrix: fine grained, Plg appears fresh, very few oxidized Ol <1mm <1-2%, black mineral angular <1% <<1mm Cpx? 8. Secondary Minerals: greenish mineral Chl?	x	x		GL				
SO258-DR39-8	1. Rock Type: volcanic, aphyric basalt, slightly to moderately altered 2. Size: 16.5x11x8cm 3. Shape / Angularity: subangular 4. Color of cut surface: light grey 5. Texture / Vesicularity: less massive than -7, vesicles along margins ~1mm 5-7% mostly open, some filled with Mn, FeOH 7. Matrix: fine grained, Plg-Cpx groundmass 8. Secondary Minerals: vesicle fillings	x	x						
SO258-DR39-9	1. Rock Type: volcanic, aphyric basalt, slightly to moderately altered, glass 2. Size: 10x9x6cm 3. Shape / Angularity: subangular 4. Color of cut surface: dark grey to brownish grey 5. Texture / Vesicularity: massive, vesicles <1mm <3% mostly open, some filled with Mn, FeOH 7. Matrix: fine grained, Plg, Px, altered Ol in groundmass 8. Secondary Minerals: very few green minerals Chl?	x	x		GL				

Appendix 2 (Station Details and Rock Description)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR39-10	1. Rock Type: volcanic, aphyric basalt, low to moderately altered, glass 2. Size: 10x9x6cm 3. Shape / Angularity: angular 4. Color of cut surface: light grey with whitish areas 5. Texture / Vesicularity: fine grained, massive, vesicles <2mm <5% filled with Mn, FeOH and greenish material Chl? 7. Matrix: very fine grained, Plg, Px, very few altered Ol 8. Secondary Minerals: very few green minerals Chl? in vesicles	x			GL				
SO258-DR39-11	1. Rock Type: volcanic, aphyric basalt, low to moderately altered, glass 2. Size: 14.5x10x5cm 3. Shape / Angularity: angular 4. Color of cut surface: light grey 5. Texture / Vesicularity: massive, few vesicles <1mm <2% some filled 6. Phenocrysts: very few <<<1% Px moderately to strongly altered 7. Matrix: fine grained, Plg white rel. fresh, Px, altered Ol 8. Secondary Minerals: few greenish minerals Chl? 9. Encrustations: thin Mn crust	x	x		GL				
SO258-DR39-12	1. Rock Type: volcanic, aphyric basalt, moderately altered, glass 2. Size: 21x11x9cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey with grey greenish parts 5. Texture / Vesicularity: massive, abundant vesicles ~1mm 5-7% filled with Mn 7. Matrix: fine grained, black white matrix made of fresh Plg & Px 8. Secondary Minerals: few greenish spots Chl? 9. Encrustations: thin Mn crust 10. Comment: glass?	x	x		GL				
SO258-DR39-13	1. Rock Type: volcanic, aphyric basalt, moderately altered, glassy margin? 2. Size: 13x8x7cm 3. Shape / Angularity: subangular 4. Color of cut surface: light to dark grey with blackish dots 5. Texture / Vesicularity: massive, abundant vesicles 7% filled with Mn, cracks cutting across rock, enhanced alteration along cracks 7. Matrix: fine grained, black white matrix made of fresh Plg & Px, oxidized Ol or filled vesicles 8. Secondary Minerals: not observed 9. Encrustations: thin Mn crust, oxidized, glass	x	x		GL				
SO258-DR39-14	1. Rock Type: volcanic, aphyric basalt, moderately altered, glassy margin? 2. Size: 13x8x7cm 3. Shape / Angularity: subangular 4. Color of cut surface: light to dark grey with blackish dots 5. Texture / Vesicularity: massive, abundant vesicles 7% filled with Mn, cracks cutting across rock, enhanced alteration along cracks 7. Matrix: fine grained, black white matrix made of fresh Plg & Px, oxidized Ol or filled vesicles 8. Secondary Minerals: not observed 9. Encrustations: thin Mn crust, oxidized, glass	x	x		GL				

Appendix 2 (Station Details and Rock Description)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR39-15	1. Rock Type: volcanic, aphyric basalt, moderately to strongly altered, possible fresh glassy margin 2. Size: 14x14x9cm 3. Shape / Angularity: angular 4. Color of cut surface: grey with beige brownish parts 5. Texture / Vesicularity: massive but some cracks, enhance alteration along cracks, vesicles <10% <1mm filled with Mn 7. Matrix: fine grained, black white matrix made of fresh Plg & Px 50:50, some relatively fresh 8. Secondary Minerals: in some vesicles greenish material 9. Encrustations: thin Mn crust, glassy margin, fresh glass?	x	x		GL				
SO258-DR39-16	1. Rock Type: volcanic, aphyric basalt, fresh glass crust, matrix strongly altered 2. Size: 7x5.5x1.5cm 4. Color of cut surface: grey to brown 7. Matrix: fine grained, Ol <<1mm ~3%, Plg+Px not fresh 8. Secondary Minerals: in vesicles greenish material 10. Comment: glassy margin				GL				
SO258-DR39-17	1. Rock Type: volcanic, aphyric basalt, fresh glass crust, matrix moderately altered 2. Size: 4.5x4x3.5cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey 5. Texture / Vesicularity: massive with small cracks, small vesicles 3-5% <<1mm some with Mn fills 7. Matrix: fine grained, few Px and Fsp visible 9. Encrustations: Mn coating 10. Comment: glassy margin				GL				
SO258-DR39-18	1. Rock Type: volcanic, aphyric basalt, fresh glassy margin, rather strongly altered matrix 2. Size: 11x6x7cm 3. Shape / Angularity: subangular 4. Color of cut surface: beige, light grey 5. Texture / Vesicularity: massive, small vesicles ~3% <1mm some with Mn fills 7. Matrix: fine grained, Px fresh ~40% of groundmass, Fsp fresh 50-60% of groundmass 8. Secondary Minerals: green Chl? 9. Encrustations: Mn coating 10. Comment: glassy margin				GL				
SO258-DR39-19	1. Rock Type: volcanic, aphyric basalt, variably altered margin but with glassy margin 2. Size: 7x5x5cm 3. Shape / Angularity: subangular 4. Color of cut surface: beige to grey 5. Texture / Vesicularity: massive, vesicles ~5-7% <1mm to 3mm mostly filled with Mn or FeOH 7. Matrix: fine grained, more Fsp, some Px 8. Secondary Minerals: Chl? 10. Comment: fresh glassy margin				GL				

Appendix 2 (Station Details and Rock Description)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR39-20	1. Rock Type: volcanic, aphyric basalt, moderately altered, fresh glassy margin 2. Size: 8x9x3cm 3. Shape / Angularity: subangular 4. Color of cut surface: beige to grey 5. Texture / Vesicularity: massive, vesicles ~7% <<1mm filled with Mn or FeOH 7. Matrix: fine grained, rare oxidized Ol <<1mm <1%, Fsp & Px 8. Secondary Minerals: Chl? 10. Comment: fresh glass				GL				
SO258-DR39-21	1. Rock Type: volcanic, aphyric basalt, moderately altered, fresh glassy margin 2. Size: 5x5.5x4.5cm 3. Shape / Angularity: rounded to subangular 4. Color of cut surface: grey & dark grey 5. Texture / Vesicularity: massive, vesicles filled with white / beige material ~2% <1mm 7. Matrix: rare oxidized Ol <<1mm <1%, black/white matric made of Fsp & Px, 50:50. Some Plg well crystallized and Px also in good shape 10. Comment: fresh glass				GL				
SO258-DR39-22	1. Rock Type: volcanic, aphyric basalt, slightly to moderately altered, fresh glassy margin 2. Size: 6.5x4.5x2.5cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey & dark light 5. Texture / Vesicularity: massive, vesicles ~1% <<1mm some filled with Mn 7. Matrix: fine grained rare, black and white matrix 8. Secondary Minerals: Chl in vesicles 10. Comment: fresh glass				GL				
SO258-DR39-23	1. Rock Type: volcanic, phyric basalt, fairly fresh, glassy margin 2. Size: 14x12x8cm 3. Shape / Angularity: angular 4. Color of cut surface: grey with white patches 5. Texture / Vesicularity: massive, vesicles ~1-2% <1mm some filled with Mn 6. Phenocrysts: Fsp microphenocrysts 10% ~mm white needle shaped 7. Matrix: fine grained rare, Plg and Px appear fresh 8. Secondary Minerals: greenish dark mineral, not in vesicles 10. Comment: glass crust	x	x						
SO258-DR39-24	1. Rock Type: volcanic, aphyric basalt, moderatley altered, glassy margin 2. Size: 7x10x7cm 3. Shape / Angularity: angular 4. Color of cut surface: light to dark grey 5. Texture / Vesicularity: massive, vesicles ~3-5% <1mm mostly filled with Mn or Chl 7. Matrix: fine grained rare, Plg and Px ~50:50, Px relativley fresh and well crystallized 8. Secondary Minerals: Chl in vesicles 9. Encrustations: thin Mn crust 10. Comment: glass crust	x	x						

SO258-DR40

Description of Location and Structure: Afanasy Nikitin, southern part at eastern margin. S facing slope of faulted block like structure

Dredge on bottom UTC 25/06/17 11:58 hrs, lat 5°01.21'S, long 82°58.27'E, depth 4750m
Dredge off bottom UTC 25/06/17 13:11 hrs, lat 5°1.31'S, long 82°58.51'E, depth 4430m
total volume: 1/3 full
Comments: Lots of crusts incl. Mn crusts, few magmatic rocks. Ol-Fsp-Px phyric lava fragments. -2 has chilled margin but unlikely fresh glass, -1 has fairly fresh groundmass, -3 is the most phyric rock with Fsp-Px intergrowths

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR40-1	1. Rock Type: volcanic, Ol-phyric basalt, slightly to moderately altered 2. Size: 20x15x8cm 3. Shape / Angularity: subangular to rounded 4. Color of cut surface: blueish grey with beige patches 5. Texture / Vesicularity: coarse grained, massive, vesicles <2mm <5% mostly open 6. Phenocrysts: oxidized Ol 3-5% <2mm altered to Fe oxides, iddingsite 7. Matrix: coarse grained, Px + Plg agglomerates, fresh 8. Secondary Minerals: some green minerals 9. Encrustations: very thin Mn coating 10. Comment: sample is good for GC and dating appears possible	x	x					GC in airfreight box	
SO258-DR40-2	1. Rock Type: volcanic, Ol-Fsp phyric basalt, moderately altered, possibly fresh glass in chilled margin 2. Size: 25x13x16cm 3. Shape / Angularity: angular 4. Color of cut surface: brown with grey patches 5. Texture / Vesicularity: coarse grained, massive, vesicles <2mm <5% some filled with FeOH and green material 6. Phenocrysts: oxidized Ol 5% <2mm, single Fsp elongated 0.5cm 7. Matrix: coarse grained, Ol, Fsp, Px 8. Secondary Minerals: some green minerals in vesicles 9. Encrustations: thin Mn coating 10. Comment: chilled margin, fresh glass?	x	x						
SO258-DR40-3	1. Rock Type: volcanic, Fsp-Px porphyric basalt, moderately to strongly altered groundmass 2. Size: 16x14x13cm 3. Shape / Angularity: subangular to rounded 4. Color of cut surface: red-brown with grey and white patches 5. Texture / Vesicularity: massive, vesicles ~1mm 3-5% some filled with yellow material some with Mn 6. Phenocrysts: Fsp-Px <5mm, 15% 7. Matrix: coarse grained, Fsp+Px agglomerates 8. Secondary Minerals: green minerals in vesicles 9. Encrustations:very thin Mn coating	x	x						
SO258-DR40-4Mn	1. Rock Type: Mn crust 2. Size: 22x15x8cm, Mn 5cm, mudstone 3cm 3. Shape / Angularity: rounded 4. Color of cut surface: Mn black, mudstone multicolor layers of brown, beige and light grey 9. Encrustations: thick Mn crust								no pic

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR40-5Mn	1. Rock Type: mudstone with Mn crust 2. Size: 23x16x12cm, Mn crust 0.5-2cm, mudstone 8cm 3. Shape / Angularity: rounded 4. Color of cut surface: Mn black, mudstone multicolor layers of redbrown 3cm, brown 5.5cm and greybrown 1cm 5. Texture / Vesicularity: redbrown layer contains black Mn infills, some fragments with white patches, brown horizon light fragments perpendicular to layering 9. Encrustations: Mn crust								

SO258-DR41

Description of Location and Structure: Afanasy Nikitin, southern margin. NW flank of largest seamount in the area. NW-SE elongated but oval shaped. Steep slope / step at base.

Dredge on bottom UTC 25/06/17 19:07 hrs, lat 4°53.66'S, long 82°39.89'E, depth 4180m
Dredge off bottom UTC 25/06/17 20:35 hrs, lat 4°54.05'S, long 82°40.19'E, depth 3777m
total volume: 1/5 full
Comments: angular lava fragments & crusts, strongly altered pillow fragments with minor Fsp microphenocrysts, no fresh glass

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR41-1	1. Rock Type: volcanic, aphyric basalt, strongly altered 2. Size: 10x14x10cm 3. Shape / Angularity: subangular 4. Color of cut surface: beige to grey, light grey patches 5. Texture / Vesicularity: massive but many cracks with dendritic Mn, vesicles <1mm <7% open 6. Phenocrysts: Fsp microphenocrysts 10% <1mm 7. Matrix: fine grained, Px + Plg in groundmass <1mm, Fsp>Px 8. Secondary Minerals: FeOH in few vesicles 9. Encrustations: thick Mn crust (removed)	x	x						
SO258-DR41-2	1. Rock Type: volcanic, aphyric basalt, strongly altered 2. Size: 12x9x5cm 3. Shape / Angularity: angular 4. Color of cut surface: brown-beige with grey patches, some greyish parts 5. Texture / Vesicularity: massive with many cracks and dendritic Mn, vesicles <1mm <5% mostly open, some with FeOH infill 6. Phenocrysts: Fsp-Px microphenocrystic agglomerates ~5% <2mm 7. Matrix: fine grained, mostly Px + Plg 8. Secondary Minerals: FeOH in few vesicles along margin 9. Encrustations: thick Mn crust 10. Comment: maybe glass in cutoff margin but very unlikely	x	x					GC in airfreight box	

Appendix 2 (Station Details and Rock Description)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR41-3	1. Rock Type: volcanic, rather aphyric basalt, strongly altered 2. Size: 14x9x5cm 3. Shape / Angularity: angular 4. Color of cut surface: brownish fewer areas beige grey 5. Texture / Vesicularity: massive with many cracks and dendritic Mn, vesicles <1mm 1-3% some filled with greenish material 6. Phenocrysts: maybe Fsp-Px ~1% <2mm 7. Matrix: fine grained mostly Px+Fsp 8. Secondary Minerals: in vesicles 9. Encrustations: mm thick Mn crust	x	x					GC in airfreight box	
SO258-DR41-4	1. Rock Type: volcanic, aphyric basalt, strongly altered 2. Size: 13x9x6cm 3. Shape / Angularity: angular 4. Color of cut surface: brown with grey patches 5. Texture / Vesicularity: massive with cracks and dendritic Mn, vesicles <1mm 3% some larger 1cm <1% 6. Phenocrysts: Fsp microphenocrysts ~5-7% <5mm 7. Matrix: fine grained, Fsp>Px, due alteration difficult to quantify 9. Encrustations: few mm thick Mn crust	x	x						
SO258-DR41-5	1. Rock Type: altered hyaloclastite with abundant glass fragments in various stages of glass alteration 2. Size: 7x7x4cm 3. Shape / Angularity: rounded 4. Color of cut surface: green-brown 5. Texture / Vesicularity: altered glass fragments, vesicles <1mm 3-5% unfilled 7. Matrix: altered glass 8. Secondary Minerals: Chl, palagonite								
SO258-DR41-6	1. Rock Type: altered hyaloclastite with abundant glass fragments in various stages of glass alteration but less altered than -5 2. Size: 8x5x5cm 3. Shape / Angularity: rounded 4. Color of cut surface: brown & green, beige 5. Texture / Vesicularity: glassy green areas, vesicles <<1mm 1%, brown areas vesicles <<1mm ~3% 7. Matrix: oxidized Ol <<1mm ~2%, Fsp laths 8. Secondary Minerals: Chl, green parts								

SO258-DR42

Description of Location and Structure: Afanasy Nikitin, southern area, western flank. N-S trending scarp at W- margin of Afanasy Nikitin, probably a fracture zone. W facing slope from base to top

Dredge on bottom UTC 26/06/17 02:28 hrs, lat 5°00.51'S, long 82°18.05'E, depth 5044m
Dredge off bottom UTC 26/06/17 03:40 hrs, lat 5°00.53'S, long 82°18.43'E, depth 4650m
total volume: a few Mn nodules
Comments: Mn nodules only

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR42-1	1. Rock Type: Mn-nodule with fragments of palagonite, very strongly altered 2. Size: 3x3x2cm 3. Shape / Angularity: rounded 4. Color of cut surface: Mn = black, palagonite = green 9. Encrustations: Mn crust 5mm								
SO258-DR42-2	1. Rock Type: Mn-nodule with fragments of palagonite, very strongly altered 2. Size: 7x4x4cm								

SO258-DR45

Description of Location and Structure: Afanasy Nikitin Complex, southern area, western flank. W dipping flank of N-S trending scarp, probably a fracture zone, from base to top

Dredge on bottom UTC 26/06/17 23:03 hrs, lat 4°39.73'S, long 82°18.89'E, depth 4992m
Dredge off bottom UTC 26/06/17 00:55 hrs, lat 4°39.71'S, long 82°19.40'E, depth 4396m
total volume: 1/4 full
Comments: Mostly basalts ranging from strongly Plg phyric (50% crysts) to aphyric. Plg is fresh in most rocks, some are medium crystallized and can be used for matrix dating. Sample -19 is unusual due to high vesicularity. Mn crusts usually include volcaniclastics.

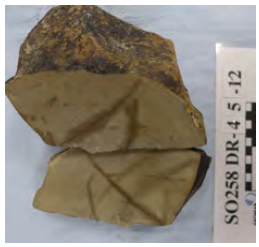
SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR45-1	1. Rock Type: volcanic, Plg phyric basalt, strongly altered matrix, abundant cracks, part of block E 2. Size: 25x19x18cm original size 3. Shape / Angularity: rounded 4. Color of cut surface: brownish with large, dark Plg crystals 5. Texture / Vesicularity: <1% vesicles 6. Phenocrysts: Plg 5-10% <5mm 7. Matrix: fine grained 8. Secondary Minerals: Mn close to rim and along cracks 9. Encrustations: Mn crust 3-4 cm thick 10. Comment: Plg is fresh and abundant, needs careful picking to avoid Mn veins	x	x						

Appendix 2 (Station Details and Rock Description)

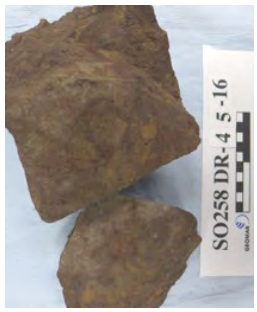
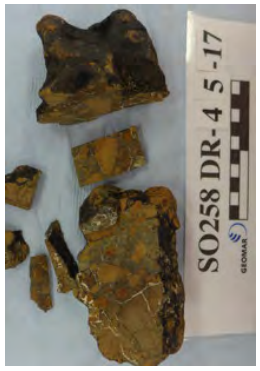
SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR45-2	1. Rock Type: volcanic, strongly Plg phyric basalt, moderately altered matrix 2. Size: 10x4.5x5cm 3. Shape / Angularity: subangular 4. Color of cut surface: yellowish grey with grey spots 5. Texture / Vesicularity: porphyric, rare vesicles 6. Phenocrysts: Plg ~50% up to 7mm, partly altered 7. Matrix: medium grained intersertal Plg + Px 8. Secondary Minerals: medium to strongly, Ol + Px are not preserved ---> oxidized 9. Encrustations: thin Mn coating <1mm 10. Comment: Plg is mostly fresh and appears suitable for dating, rel. good for geochemistry (no Mn veins)	x	x						
SO258-DR45-3	1. Rock Type: volcanic, Plg phyric basalt, moderately altered. 2. Size: 7.5x4.5x5cm : 10. Comment: petrographycally similar to -2 but has somewhat less Plg (~30-40%) and more abundant small vesicles (~5%). Plg is fresh and Mn along thin veins, requires picking for geochemistry	x	x						
SO258-DR45-4	1. Rock Type: volcanic, Plg phyric basalt, moderately altered, similar to -2 & -3 2. Size: 13x8x9cm 3. Shape / Angularity: subangular 8. Secondary Minerals: somewhat more oxidized, thin veins of Mn cutting through the rock 9. Encrustations: Mn film and some mud on outer surface 10. Comment: see comments for -2 & -3	x	x					GC in airfreight box	
SO258-DR45-5	1. Rock Type: volcanic, Plg phyric basalt, moderately altered 2. Size: 11x6x6cm 3. Shape / Angularity: subangular 4. Color of cut surface: yellowish grey 5. Texture / Vesicularity: porphyric, massive groundmass 6. Phenocrysts: Plg 10% up to 5-6mm fresh; Ol ~2-3% <1mm in intergrowth with Plg, altered black 7. Matrix: massive, fine to medium grained, oxidized 8. Secondary Minerals: pervasive oxidation, some rare veins of Mn oxides 9. Encrustations: thin Mn film on outer surface 10. Comment: the sample is similar to -2 through -4 but has smaller amount of Plg. Plg is mostly fresh and groundmass ~ok for geochemistry	x	x						

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR45-6	1. Rock Type: volcanic, aphyric basalt, moderately altered 2. Size: 10x9x9cm 3. Shape / Angularity: subrounded 4. Color of cut surface: yellowish grey 5. Texture / Vesicularity: massive, dense groundmass, no vesicles visible 7. Matrix: massive, medium grained, light crystals = altered Cpx needles, sceleton shapes; Plg in intersertials altered 8. Secondary Minerals: pervasive oxidation 9. Encrustations: Mn coating, rare cracks with Mn-Fe oxides 10. Comment: the rock is moderately to strongly altered but maybe not too bad for geochemistry, no intense picking needed, simply avoid outer Mn crust	x	x						
SO258-DR45-7	1. Rock Type: volcanic, aphyric basalt, moderately altered 2. Size: 13x12x4cm 3. Shape / Angularity: subangular 4. Color of cut surface: yellowish grey with black dots 10. Comment: the rock is very similar to -6. Pervasive alteration / oxidation but no Mn veins, should be good for geochemistry	x	x					see -6	
SO258-DR45-8	1. Rock Type: volcanic, aphyric basalt, moderately to strongly altered 2. Size: 11x11x5cm 10. Comment: the rock is very similar to -6 & -7. Pervasive alteration / oxidation can not be avoided by picking	x	x					see -6	
SO258-DR45-9	1. Rock Type: volcanic, rare Plg phyric basalt, moderately to strongly altered 2. Size: 11x7x3cm 3. Shape / Angularity: subangular 4. Color of cut surface: yellowish grey 5. Texture / Vesicularity: massive 6. Phenocrysts: very rare, large 3-4mm Plg 7. Matrix: fine grained, but overall similar to all other samples 8. Secondary Minerals: some thin veins filled with Mn oxide	x	x						
SO258-DR45-10	1. Rock Type: volcanic, aphyric basalt, moderately altered 2. Size: 8x6x5.5cm 3. Shape / Angularity: subangular 4. Color of cut surface: slightly yellowish grey 5. Texture / Vesicularity: massive, very rare vesicles filled with light mineral 6. Phenocrysts: none 7. Matrix: fine grained, somewhat more leukocratic compared to other samples 8. Secondary Minerals: a few very thin veins with Mn 9. Encrustations: outer Mn film <1mm 10. Comment: the sample is ~good for GC, TS should be inspected beforehand	x	x						

Appendix 2 (Station Details and Rock Description)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR45-11	1. Rock Type: volcanic, aphyric basalt, moderately altered, oxidized 2. Size: 10x10x6cm 4. Color of cut surface: purple to dark grey with black spots 5. Texture / Vesicularity: massive, dense 6. Phenocrysts: none 7. Matrix: medium to coarse crystallized 8. Secondary Minerals: heterogeneously oxidized, spoty purple yellow zones. Numerous veins filled with Mn oxided 9. Encrustations: thin outer Mn crust <1mm 10. Comment: due to pervasive oxidation sample may not be very good for geochemistry but Plg is fresh and rel. well crystallized matrix make Ar-Ar dating feasible	x	x						
SO258-DR45-12	1. Rock Type: volcanic, aphyric basalt, moderately altered, part of block F 2. Size: 17x14x8cm sample. 22x14x16cm original size 10. Comment: the sample is similar to -6. Rel. good for gechemistry, veins should be avoided by picking	x	x				see -6	GC in airfreight box	
SO258-DR45-13	1. Rock Type: volcanic, rare Ol phyric basalt, moderately to strongly altered 2. Size: 9x7x6cm 3. Shape / Angularity: subangular 4. Color of cut surface: brown with rare black dots 5. Texture / Vesicularity: massive, very rare vesicles filled with whitish mineral 6. Phenocrysts: Ol 1-2% up to 2mm, latered to black 7. Matrix: fine grained, oxidized 8. Secondary Minerals: Mn along cracks 9. Encrustations: Mn on outer surface 10. Comment: the sample is different from all others, moderate to strong alteration, not too bad for geochemistry	x	x						
SO258-DR45-14	1. Rock Type: volcanic, rare Ol phyric basalt, moderately to strongly altered, similar to -13 2. Size: 6x5x5cm 3. Shape / Angularity: subrounded 6. Phenocrysts: Ol 1-2% 0.3-0.5mm, altered to red 7. Matrix: massive, fine grained, oxidized 9. Encrustations: Mn encrustation in outer part, Mn film on outer surface	x	x						
SO258-DR45-15	1. Rock Type: volcanic, aphyric basalt, moderately to strongly altered 2. Size: 8x9x3cm 3. Shape / Angularity: subangular 4. Color of cut surface: brownish grey 5. Texture / Vesicularity: massive 7. Matrix: fine crystallized, oxidized 8. Secondary Minerals: some veins filled with Mn, should be avoided by picking 10. Comment: rel. good for geochemistry but Mn needs carefuld picking	x	x						

Appendix 2 (Station Details and Rock Description)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR45-16	1. Rock Type: volcanic breccia, altered, part of block B 2. Size: 17x14x8cm sample; 36x22x13cm original size 4. Color of cut surface: purple brown 5. Texture / Vesicularity: clastic texture, large ~2cm lava fragments in foliated fine cryst. matrix 7. Matrix: purple, strongly oxidized 8. Secondary Minerals: clasts are strongly altered purple to green; Ol basalt in clasts 10. Comment: the purple color suggests subaerial eruptions and oxidation. No GC	x							
SO258-DR45-17	1. Rock Type: volcanic breccia, strongly altered 2. Size: 11x8x5cm 5. Texture / Vesicularity: clasts of aphyric basalt in fine grained matrix 10. Comment: the sample is representative for several other similar rocks in the dredge	x							
SO258-DR45-18	1. Rock Type: volcanic, contact of very fine grained crystallized Plg phyric basalt and aphyric medium crystallized basalt 2. Size: 5.5x6.5x3cm 10. Comment: Plg phyric basalt seem to be younger and has quenched margins. No glass preserved. Aphyric basalt has some Mn veins but can be analyzed by LA-ICPMS in chips or TS	x							
SO258-DR45-19	1. Rock Type: volcanic, highly altered hyloclastite 2. Size: 6x5x3cm 10. Comment: clasts are aphyric vesicular rocks / glasses. Very fine crystallized groundmass. The clasts look different from the other rocks in dredge and could represent another rock type. Clasts are too small for whole rock geochem; but can be lasered	x							
SO258-DR45-20Mn	1. Rock Type: Mn nodule 2. Size: 14x7x5cm 3. Shape / Angularity: rounded 10. Comment: inner part = altered volcaniclastics, outer part ~1cm thick dense Mn crust								

SO258-DR46

Description of Location and Structure: Afanasy Nikitin Complex, southern area, western flank. Ridge like structure atop of the broad plateau, west-central part of the ridge, entire slope from base to crest

Dredge on bottom UTC 27/06/17 05:38 hrs, lat 4°33.22'S, long 82°22.66'E, depth 3740m

Dredge off bottom UTC 27/06/17 06:49 hrs, lat 4°33.06'S, long 82°22.99'E, depth 3340m

total volume: 1/4 full

Comments: Three different lava types sampled. 1) Ol-Plg phyric basalt (-1 to -7 and 17), moderately altered matrix but abundant large, fresh Plg good for Ar-Ar dating, 2) Ol phyric lava (-9, -10, -13) with up to 15-20% altered Ol ø 1mm in moderately altered matrix, 3) aphyric lava (-8, -11, -12) strongly altered matrix but -8 has chilled margin with fresh glass. Additional lithology sampled are strongly altered hyaloclastites that either have (-14) or potentially have (-15) fresh glass cores for spot analysis.

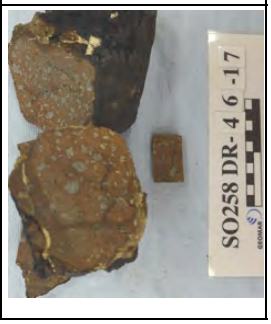
SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR46-1	1. Rock Type: volcanic, Ol-Plg phyric basalt, moderately altered 2. Size: 23x13x11cm 3. Shape / Angularity: subangular 4. Color of cut surface: dark orange outer part, more grey in center 5. Texture / Vesicularity: ~10-15% ~3-4cm vesicles along outer part, <5% in center 0.5 - 1mm, lined with Mn 6. Phenocrysts: Plg 30-40% up to 1cm; Ol ~5-10%, small crystals <1mm, altered to Fe oxides 7. Matrix: intersertal, fine crystallized, glassy margin 8. Secondary Minerals: strong oxidation in outer part, some thin veins with Mn 10. Comment: large fresh Plg, fresh glass in margin, rel. good inner part for geochemistry	x	x	1-2	GL			GC in airfreight box	
SO258-DR46-2	1. Rock Type: volcanic, large clast of Ol-Plg phyric basalt from volcaniclastic breccia 2. Size: 12x12x6cm 4. Color of cut surface: dark brown somewhat purple with red and grey crystals (Ol + Plg) 5. Texture / Vesicularity: massive, <5% <1mm, lined with Mn 6. Phenocrysts: Plg 30-40% up to 1cm fresh; Ol ~5-7% up to 3mm, altered to Fe oxides 7. Matrix: intersertal, fine grained, somewhat oxidized 8. Secondary Minerals: oxidation in matrix and after Ol, some thin veins with Mn 9. Encrustations: thion Mn coating on outer surface 10. Comment: rel. good for geochemistry, moderately altered, fresh good Plg	x	x	2	Plg				
SO258-DR46-3	1. Rock Type: volcanic, Ol-Plg phyric basalt, similar to -2 2. Size: 12x11x6cm 10. Comment: some Mn veins but overall very similar to -2 in terms of quality and degree of alteration	x	x	2	Plg				
SO258-DR46-4	1. Rock Type: volcanic, Ol-Plg phyric basalt, similar to -2 but more oxidized with less Plg (~15%) 2. Size: 12x12x7cm 6. Phenocrysts: Plg fresh up to 1cm ø 10. Comment: the sample is more altered compared to -2 and -3, contains numerous veins with Mn. Overall not good for geochemistry, Plg fresh good for dating	x	x		Plg			see -2	

Appendix 2 (Station Details and Rock Description)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR46-5	1. Rock Type: volcanic, Ol-Plg phyric basalt, moderately altered 2. Size: 12x9x5cm 3. Shape / Angularity: subangular fragment in volcaniclastics 4. Color of cut surface: dark grey to brown with red spots (Ol) 5. Texture / Vesicularity: porphyritic, massive matrix, dense 6. Phenocrysts: Plg 5% up to 1cm ø fresh; Ol ~20% 1-2mm, replaces by Fe-oxides 7. Matrix: fine grained, rel. well preserved, some thin cracks with Mn-oxides 10. Comment: rel. "fresh" rock, ~good for geochemistry, Plg is fresh ---> dating	x	x	ok	Plg			GC in airfreight box	
SO258-DR46-6	1. Rock Type: volcanic, Ol-Plg phyric basalt, very similar to -2 2. Size: 7x4x6cm 10. Comment: rel. "fresh" rock, ~good for geochemistry and Ar-Ar dating	x	x					see -2	
SO258-DR46-7	1. Rock Type: volcanic, Ol-Plg phyric basalt, very similar to -5 2. Size: 8x7x6cm 3. Shape / Angularity: subrounded 6. Phenocrysts: rare Plg fresh, rel. abundant Ol altered 8. Secondary Minerals: more altered than -5, has many veins and white fillings of vesicles 10. Comment: maybe still good for geochemistry	x	x					see -5	
SO258-DR46-8	1. Rock Type: volcanic, aphyric basalt, strongly altered / oxidized but with fresh glass 2. Size: 13x12x7cm 3. Shape / Angularity: subangular 4. Color of cut surface: greenish grey to orange in inner part, dark brown to black in glassy margin 5. Texture / Vesicularity: brecciated, vesicles ~5% <2mm open 6. Phenocrysts: none 7. Matrix: aphanitic or hyalopilitic / cryptocrystalline 8. Secondary Minerals: very oxidized, lots of veining 10. Comment: no good for whole rock geochemistry, fresh glass in marginal part, needs picking	x	x		Gl				
SO258-DR46-9	1. Rock Type: volcanic, Ol phyric basalt, moderately altered, part of block B 2. Size: 17x18x16cm 3. Shape / Angularity: subangular 4. Color of cut surface: brownish dark grey with red spots 5. Texture / Vesicularity: massive 6. Phenocrysts: sub-phenocrysts of Ol ~15-20% <1mm altered to Fe-oxide 7. Matrix: intersertal fine to medium crystallized, somewhat oxidized 8. Secondary Minerals: thin veins with Mn oxides, Mn film on outer surface 10. Comment: the rock is relatively fresh for whole rock chemistry, veins should be avoided by picking	x	x					GC in airfreight box	

Appendix 2 (Station Details and Rock Description)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR46-10	1. Rock Type: volcanic, Ol phyric basalt, similar to -9 2. Size: 12x9x4.5cm 10. Comment: rel. good for geochemistry like -9	x	x						
SO258-DR46-11	1. Rock Type: volcanic, aphyric basalt, moderately altered / oxidized 2. Size: 10x11x8cm 3. Shape / Angularity: subrounded 5. Texture / Vesicularity: 10-15% very small vesicles 6. Phenocrysts: none; ~15-20% Plg subphenocrysts 7. Matrix: fine crystallized, oxidized 8. Secondary Minerals: numerous thin veins of Mn oxides 10. Comment: not good for geochemistry because of strong alteration and Mn encrustations	x	x						
SO258-DR46-12	1. Rock Type: volcanic, aphyric basalt, moderately altered / oxidized 2. Size: 8x5x5cm 3. Shape / Angularity: subrounded 4. Color of cut surface: yellowish grey 5. Texture / Vesicularity: 10-15% very small vesicles <0.5mm, partly filled with Mn-oxides 6. Phenocrysts: none 7. Matrix: rel. fresh, slightly oxidized 8. Secondary Minerals: numerous thin veins of Mn oxides, some thin veins 10. Comment: the rock is similar to -11 but looks fresher / better. For bulk geochemistry veins and possibly vesicles need to be avoided during preparation	x	x						
SO258-DR46-13	1. Rock Type: volcanic, Ol-phyric basalt 2. Size: 6x10x6cm 3. Shape / Angularity: subrounded 4. Color of cut surface: dark brown grey 5. Texture / Vesicularity: ~20% <2mm, open 6. Phenocrysts: Ol ~15% <1.5mm, altered to Fe-oxides 7. Matrix: fine grained oxidized 8. Secondary Minerals: rel. abundant Mn-veins, some Mn and mud on outer surface 10. Comment: overalls more altered than other samples. Taken because of rel. large amount of vesicles	x	x						
SO258-DR46-14	1. Rock Type: volcanic, altered hyaloclastite, block D 2. Size: 32x26x17cm 5. Texture / Vesicularity: clastic rock with palagonitized glass fragments up to 1.5cm 10. Comment: the rock was cut into slabs which were searched for glass. Chips with glass and representative slice of whole rock were taken				GL				

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR46-15	1. Rock Type: volcanic, altered hyaloclastite, fragments of Plg phyric basalts and former glass 2. Size: 20x14x7cm 5. Texture / Vesicularity: clasts are up to several cm in ø but mostly <2cm, palagonitized glass 6. Phenocrysts: Plg is fresh in basalt clasts 9. Encrustations: Mn crust 1cm 10. Comment: The sample is taken for potential study of Plg phenocrysts, MI's in them. Fresh glass is not excluded but was not observed				GL?				
SO258-DR46-16	1. Rock Type: volcanic, breccia, part of block C 2. Size: 34x25x10cm 9. Encrustations: Mn crust 0.5cm 10. Comment: representative sample								
SO258-DR46-17	1. Rock Type: volcanic, Plg-Ol phyric basalt, similar to -2 2. Size: 19x10x9cm 10. Comment: typical for the dredge, additional sample for archive / additional work								

SO258-DR49

Description of Location and Structure: Afanasy Nikitin Complex, central section, SW facing flank of plateau structure occupying the center of Afanasy Nikitin. Steepest portion of slope from near base to top.

Dredge on bottom UTC 27/06/17 20:28 hrs, lat 4°10.75'S, long 82°34.93'E, depth 3879m

Dredge off bottom UTC 27/06/17 21:52 hrs, lat 4°10.66'S, long 82°35.39'E, depth 3364m

total volume: very few rocks

Comments: 1x large pillow fragment with altered glass rim, matrix altered to orange-red, 1x small fragment of Plg phyric lava, moderately altered greyish groundmass, 1x hyaloclastite with alterered glass fragments but may also contain less altered glass. Fresh glass fragments found in -2 and -3

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR49-1	1. Rock Type: volcanic, Plg phyric basalt, moderately altered 2. Size: 7x4.5x5.5cm 3. Shape / Angularity: angular 4. Color of cut surface: grey to light beige, white patches = Fsp / Plg 5. Texture / Vesicularity: massive but many small vesicles <1mm, 10-15%, open 6. Phenocrysts: larger Plg microphenocrysts 3-5% <2.5mm, appear fresh 7. Matrix: fine grained, Fsp also as small needles in matrix, oxidized very small Ol, few black minerals Px? 8. Secondary Minerals: a few areas gave greenish discoloration Chl? 9. Encrustations: none 10. Comment: rel good for geochemistry, Plg maybe useful for dating but overall small sample	x	x					GC in airfreight box	

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR49-2	1. Rock Type: volcanic, aphyric pillow lava fragment, strongly altered, many large vesicles perpenducular to pillow margin 2. Size: 20x15x15cm 3. Shape / Angularity: subrounded 4. Color of cut surface: red brown interior, grey to black margin 5. Texture / Vesicularity: 5-7% very large vesicles up to several cm but also mm-sized 10% 6. Phenocrysts: none 7. Matrix: fine grained, many small needle shaped Fsp but very strongly altered, some black roundish Px? 9. Encrustations: none 10. Comment: very minor fresh glass in chilled margin	x	x		GL				
SO258-DR49-3	1. Rock Type: volcanic, strongly altered hyaloclastite of mostly altered glass and lava fragments, some fresh glass observed 2. Size: 14x14x6.5cm 3. Shape / Angularity: rounded to subangular 4. Color of cut surface: greenish matrix with brownish glass als lava fragments 5. Texture / Vesicularity: in lava fragments vesicles <1mm ~3% 6. Phenocrysts: none 7. Matrix: not observed 8. Secondary Minerals: grey parts seem fresh, inbetween green palagonite 9. Encrustations: M-crust on one side of rock, on broken side of rock shiny, reflections of glass 10. Comment: some cores in lava fragments seem fresher than outer parts. fresh glass				GL				

SO258-DR50

Description of Location and Structure: Afanasy Nikitin Complex, central section, Western margin at scarp / fault like structure

Dredge on bottom UTC 28/06/17 04:55 hrs, lat 3°46.80'S, long 82°29.34'E, depth 4459m
Dredge off bottom UTC 28/06/17 06:09 hrs, lat 3°46.59'S, long 82°29.65'E, depth 4181m
total volume: few rocks
Comments: Two rock types 1) fragments of fresh glassy Ol-Plg basalt from hyaloclastite, 2) very altered, oxidized Ol basalt

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR50-1	1. Rock Type: volcanic, rare Ol-Plg basalt, fairly fresh 2. Size: 6x4x3cm 3. Shape / Angularity: subrounded 4. Color of cut surface: black 5. Texture / Vesicularity: ~5% <1mm partly filled with semi transparent mineral, some are empty 6. Phenocrysts: Plg + Ol 5% ~0.3-0.5mm all fresh 7. Matrix: dense, glassy / hyalopilitic 8. Secondary Minerals: no signs of alteration, outer palagonitized margin removed during preparation 9. Encrustations: none 10. Comment: the sample is a clast from a hyaloclastite, very fresh. Some palagonite spots are still on surface. Light particles should be removed after crushing. No TS made made to safe more volume for GC. TS should be done at GEOMAR with precise saw	to be cut at GEOMAR	x						

Appendix 2 (Station Details and Rock Description)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR50-2	1. Rock Type: volcanic, rare Ol-Plg basalt. The sample is analogous to -1 but has well preserved glassy margin. Sample was cut into half and collected entirely as glass 2. Size: 3x4x2cm original size; palagonite removed during preparation 9. Encrustations: none				GL			see -1	
SO258-DR50-3	1. Rock Type: volcanic, basaltic glass. fragment from partly altered hyaloclastite 2. Size: 3x4x2cm 9. Encrustations: none 10. Comment: the sample is similar to 1 & 2, composed of glass. Partly palagonitized but mostly fresh in its core				GL			see -1	
SO258-DR50-4	1. Rock Type: volcanic, Ol-basalt, strongly altered 2. Size: 10x6x6cm 3. Shape / Angularity: subrounded 4. Color of cut surface: pinkish brown with orange dots, black Mn spots 5. Texture / Vesicularity: 5% <1mm voids have Mn coating 6. Phenocrysts: Ol 10% <2mm altered to Fe-oxides 7. Matrix: fine crystallized, intersertal, Plg maybe fresh 8. Secondary Minerals: pervasive oxidation, preception of Mn oxides in spots over entire sample volume 9. Encrustations: Mn crust 2mm 10. Comment: the sample is not good for geochemistry because of alteration and particularly Mn-oxides	x	x						
SO258-DR50-5	1. Rock Type: volcanic, Ol-basalt, strongly altered, similar to -4 2. Size: 9x5x4cm	x	x					see -4	
SO258-DR50-6	1. Rock Type: volcanic, Ol-basalt, strongly altered, similar to -4 but somewhat less oxidized 2. Size: 5x4x3cm 10. Comment: sample no good for GC because of Mn inside	x	x					see -4	

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR50-7	1. Rock Type: volcanic, Ol-basalt, strongly altered, very oxidized, pillow lava fragment 2. Size: 10x10x7cm	x	x					see -4	
SO258-DR50-8	1. Rock Type: volcanic, Ol-basalt, altered, similar to -4 and particularly to -6 2. Size: 7.5x7.5x3.5cm	x	x					see -4 & -6	
SO258-DR50-9	1. Rock Type: volcanic, Ol-basalt, very altered, similar to -4 2. Size: 6x3x2cm							see -4	
SO258-DR50-10	1. Rock Type: volcanic, Ol-basalt, very oxidized, very altered, similar to -4 2. Size: 8x5x4cm							see -4	

SO258-DR51

Description of Location and Structure: Afanasy Nikitin Complex, central section, NW-SE striking (tectonic?) ridge at base of Western flank of Afanasy Nikitin. SW facing flank from base to top.

Dredge on bottom UTC 28/06/17 18:31 hrs, lat 3°26.89'S, long 82°21.54'E, depth 4939m
Dredge off bottom UTC 28/06/17 19:49 hrs, lat 3°26.73'S, long 82°21.91'E, depth 4527m
total volume: empty

SO258-DR52

Description of Location and Structure: Afanasy Nikitin Complex, central section, area where MIR dives obtained Plg phyric basalt. SW dipping step in western slope

Dredge on bottom UTC 29/06/17 00:26 hrs, lat 3°24.32'S, long 82°31.45'E, depth 4325m

Dredge off bottom UTC 29/06/17 02:20 hrs, lat 3°24.07'S, long 82°31.76'E, depth 4050m

total volume: half full

Comments: pillow lava in fragments up to ø70cm, breccia. All more or less crystallized aphyric basalt. Some are fairly fresh. Style of alteration and large vesicles suggest shallow water eruption. Breccia consists of lava fragments cemented by carbonate. This suggests shallow origin and subsidence or 1000-2000m downslope transfer.

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR52-1	1. Rock Type: volcanic, aphyric basalt, slightly altered 2. Size: block B; 30x20x20cm 3. Shape / Angularity: well rounded 4. Color of cut surface: dark grey with concentric bands of dark grey to yellowish 5. Texture / Vesicularity: ~5% abundant small vesicles, irregular shape, large very elongated ø 0.5mm ~10cm long 6. Phenocrysts: none 7. Matrix: massive, well crystallized, medium grained 8. Secondary Minerals: fairly fresh with minor alteration / oxidation. Some oxidation / weathering particularly in outer part; removed when smashed on deck 10. Comment: the sample is representative of one group of samples from dredge. It has appearance and style of weathering typical of subaerially erupted rocks, perhaps in shallow water. Good for geochemistry and Ar-Ar	x	x	2+				GC in airfreight box	
SO258-DR52-2	1. Rock Type: volcanic, aphyric basalt, slightly altered 2. Size: 23x12x11cm 10. Comment: very similar to -1, but has some minor white fillings in vesicles. Good for geochemistry and Ar-Ar dating	x	x						
SO258-DR52-3	1. Rock Type: volcanic, aphyric basalt, slightly altered 2. Size: 16x15x11cm 10. Comment: very similar to -1, like -2 has some white fillings in vesicles	x	x						
SO258-DR52-4	1. Rock Type: volcanic, aphyric basalt, slightly altered in core 2. Size: 16x11x8cm 10. Comment: very similar to -1, but has some Mn incrustations and is more oxidized / altered	x	x						

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR52-5	1. Rock Type: volcanic, aphyric basalt, moderately to slightly altered 2. Size: part og block A; 70x40x40cm original size 3. Shape / Angularity: angular, large pillow lava fragment 4. Color of cut surface: dark grey with concentric zoning, redish grey closer to margin 5. Texture / Vesicularity: vesicularity increases from center to rim, 5% in core, 30% at margin 6. Phenocrysts: none 7. Matrix: glassy in margin, massive intersertal in core, medium grained 8. Secondary Minerals: some minor to moderate alteration / oxidation in margin, palagonite after glass 9. Encrustations: Mn ~1-2mm on outer surface, along cracks 10. Comment: rock similar to -1 but with clear pillow lava shape, fresh glass. GC piece made of a core part of one segment.	x	x		GL two bags				
SO258-DR52-6	1. Rock Type: breccia composed of pillow lava fragments cemented by limestone 2. Size: 13x15x13cm 3. Shape / Angularity: angular 4. Color of cut surface: clasts are up to ø7cm. They are the same aphyric basalts but represent fragments of small pillows 7. Matrix: fairly fresh but voids and Mn should be avoided by picking. 10. Comment: fresh glass in margins	x			GL A-B-C from different clasts				
SO258-DR52-7	1. Rock Type: volcanic, aphyric basalt, pillow lava fragment, similar to -6 2. Size: 4x8x5cm 10. Comment: only glass taken + left overs				GL			see -6	
SO258-DR52-8	1. Rock Type: volcanic, aphyric basalt, similar to -6 2. Size: 8x6x4cm 10. Comment: fresh glass + left overs				GL			see -6	
SO258-DR52-9	1. Rock Type: volcanic, aphyric basalt, similar to -6 2. Size: 5x8x7cm 10. Comment: fresh glass + left overs				GL			see -6	

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR52-10	1. Rock Type: volcanic, aphyric basalt, similar to -6 2. Size: 11x7x7cm 10. Comment: fresh glass + left overs				GL			see -6	

SO258-DR53

Description of Location and Structure: Afanasy Nikitin Complex, central section, tiny seamount at the base of western slope

Dredge on bottom UTC 29/06/17 11:11 hrs, lat 3°8.55'S, long 82°28.95'E, depth 4469m
Dredge off bottom UTC 29/06/17 12:51 hrs, lat 3°8.54'S, long 82°29.30'E, depth 4203m
total volume: single large pillow
Comments: Plg phyric pillow basalt with chilled margin that contains abundant fresh glass. Groundmass strongly oxidized; Fsp crystals appear fresh. Sample -1 through 9 are from large pillow block A

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR53-1	1. Rock Type: volcanic, glassy pillow egg from Fsp phyric pillow basalt, strongly altered matrix but abundant fresh glass in chilled margin. 2. Size: 35x30x23cm orginal size block A, sample 12x11x9cm 3. Shape / Angularity: egg is rounded 4. Color of cut surface: matrix brown with white mm-sized Fsp, glass grey 5. Texture / Vesicularity: many vesicles & cracks, sometimes connected, <5mm ~5% vesicles 6. Phenocrysts: Fsp 5% up to several mm, fairly fresh 7. Matrix: no groundmass minerals visible 8. Secondary Minerals: strongly oxidized matrix 9. Encrustations: 1-2cm thick glass crust, fresh in most places, <2mm Mn crust 10. Comment: glassy egg with lots of fresh glass				GL				
SO258-DR53-2	1. Rock Type: volcanic, piece from Fsp phyric pillow basalt (block A), strongly altered matrix but chilled margin contains fresh glass 2. Size: 35x30x23cm orginal size block A, sample 21x18x11.5cm 3. Shape / Angularity: subangular 4. Color of cut surface: matrix brownish-orange with white mm-sized Fsp, glass grey 5. Texture / Vesicularity: more cracks than -1, vesicles filled with white material Cc? 6. Phenocrysts: Fsp 5% <5mm, fairly fresh 7. Matrix: massive, Fsp needles 8. Secondary Minerals: strongly oxidized matrix 9. Encrustations: <1cm thick glass crust, fresh glass preserved, <2mm Mn crust 10. Comment:	x	x		GL				

Appendix 2 (Station Details and Rock Description)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR53-3	1. Rock Type: volcanic, piece from Fsp phyric pillow basalt (block A), similar to -2 2. Size: 35x30x23cm orginal size block A, sample 26x13x14cm 3. Shape / Angularity: 4. Color of cut surface: 5. Texture / Vesicularity: 6. Phenocrysts: Fsp 5% <5mm, fairly fresh 7. Matrix: less oxidized than -2, fresh Fsp mircophenocrysts 8. Secondary Minerals: strongly oxidized matrix 9. Encrustations: Cc matrix with glass and lava fragments attached to margin 10. Comment: fresh glass in chilled margin	x	x		GL				
SO258-DR53-4	1. Rock Type: volcanic, piece from Fsp phyric pillow basalt (block A), similar to -2 2. Size: 35x30x23cm orginal size block A, sample 17x12x9.5cm 3. Shape / Angularity: subangular 4. Color of cut surface: 5. Texture / Vesicularity: 2-3% <1mm, some filled with Cc 6. Phenocrysts: Fsp 3% <5mm, seem mostly fresh 7. Matrix: oxidized, some Fsp mircophenocrysts 8. Secondary Minerals: strongly oxidized matrix 10. Comment: fresh glass in chilled margin				GL				
SO258-DR53-5	1. Rock Type: volcanic, piece from Fsp phyric pillow basalt (block A), similar to -2 2. Size: 35x30x23cm orginal size block A, sample 25x22x13cm 5. Texture / Vesicularity: 2-3% <1mm, some filled with Cc 6. Phenocrysts: Fsp 3-5% <5mm, seem mostly fresh 7. Matrix: oxidized, some Fsp mircophenocrysts, maybe Px next to Fsp 8. Secondary Minerals: strongly oxidized matrix 9. Encrustations: thin Mn crust 10. Comment: fresh glass in chilled margin	x	x		GL				
SO258-DR53-6	1. Rock Type: volcanic, piece from Fsp phyric pillow basalt (block A), similar to -2 2. Size: 35x30x23cm orginal size block A, sample 25x22x13cm 5. Texture / Vesicularity: 3-5% <2mm, some filled with Cc 6. Phenocrysts: Fsp 5% <6mm, mostly fresh 7. Matrix: oxidized, some Fsp mircophenocrysts 8. Secondary Minerals: strongly oxidized matrix 9. Encrustations: thin Mn crust 10. Comment: fresh glass in chilled margin, Plg seems fresh	x	x		GL			GC in airfreight box	
SO258-DR53-7	1. Rock Type: volcanic, piece from Fsp phyric pillow basalt (block A), similar to -2 2. Size: 35x30x23cm orginal size block A, sample 8x13.5x9.5cm 3. Shape / Angularity: subangular to rounded 5. Texture / Vesicularity: fewer vesicles 2% <1mm, some filled with Cc 6. Phenocrysts: fewer Fsp 2-3% <5mm, mostly fresh 7. Matrix: oxidized, very few Fsp mircophenocrysts 8. Secondary Minerals: strongly oxidized matrix 9. Encrustations: thin Mn crust 10. Comment: fresh glass in chilled margin save, matrix discarded				GL				

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR53-8	1. Rock Type: volcanic, piece from Fsp phyric pillow basalt (block A), similar to -7 2. Size: 35x30x23cm orginal size block A, sample 11x8x5cm 10. Comment: Cc vein in outer part of piece, glassy margin				GL				
SO258-DR53-9	1. Rock Type: volcanic, piece from Fsp phyric pillow basalt (block A), similar to -7 & -8 2. Size: 35x30x23cm orginal size block A, sample 8x4x5.5cm 10. Comment: only glassy margin saved				GL				
SO258-DR53-10	1. Rock Type: volcanic, Fsp phyric pillow basalt, strongly altered, this is a seperate rock apart from block A (-1 to -9) 2. Size: 14x13x11.5cm 3. Shape / Angularity: subangular 4. Color of cut surface: brownish-orange with light Plg phenocrysts and Mn dots 5. Texture / Vesicularity: massive with many cracks, vesicles <2mm 2-3%, mostly open, when filled then Cc 6. Phenocrysts: Fsp <5mm ~2mm 7. Matrix: very strongly oxidized, Fsp needles in matrix 8. Secondary Minerals: Cc in vesicles 9. Encrustations: glas crust, thin Mn crust 10. Comment: glassy margin cut off	x	x		GL				

SO258-DR59

Description of Location and Structure: Afanasy Nikitin Complex, Northern section, Seamount B of Krishna et al. 2014. Southern flank along small valley beneath plateau edge; steepest section in upper slope.

Dredge on bottom UTC 30/06/17 21:21 hrs, lat 3°21.48'S, long 83°13.65'E, depth 2812m
Dredge off bottom UTC 30/06/17 23:11 hrs, lat 3°21.11'S, long 83°13.96'E, depth 2376m
total volume: empty! Despite many bites and two stuck dredges

SO258-DR60

Description of Location and Structure: Afanasy Nikitin Complex, Northern section, Seamount B of Krishna et al. 2014. Repeat of DR59 3.5nm further W. SW facing slope of nose / ridge that lies 300 m beneath plateau edge.

Dredge on bottom UTC 01/07/17 01:36 hrs, lat 3°20.85'S, long 83°10.59'E, depth 3030m
Dredge off bottom UTC 01/07/17 03:22 hrs, lat 3°20.46'S, long 83°10.92'E, depth 2610m
total volume: few rocks
Comments: limestones, few Mn crusts. No volcanic rocks could be obtained from Seamount B

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR60-1	1. Rock Type: sediment, limestone with Mn coating 2. Size: 20x20x12cm 3. Shape / Angularity: rounded 4. Color of cut surface: white 9. Encrustations: Mn coating 2mm 10. Comment: semi-consolidated, no shells								

SO258-DR61

Description of Location and Structure: Afanasy Nikitin Complex, Northern section, Eastern margin E of Afanasy Nikitin Seamount, WNW-ESE trending fault like structure with 300m displacement, dredge along entire slope

Dredge on bottom UTC 01/07/17 09:09 hrs, lat 3°5.41'S, long 83°16.60'E, depth 4370m

Dredge off bottom UTC 01/07/17 10:34 hrs, lat 3°5.24'S, long 83°17.04'E, depth 4070m

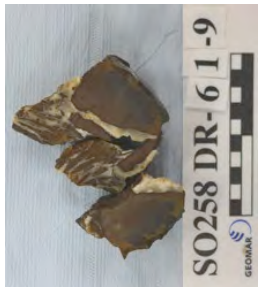
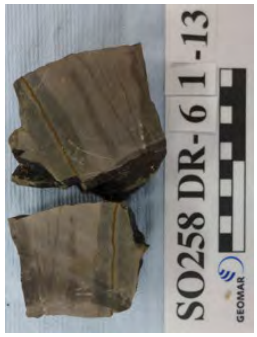
total volume: few rocks

Comments: several fragments of dense, aphyric trachytic(?) lava with flow banding structure recovered. They differ in degree of oxidation and degree of groundmass crystallization. -1 to -5 are most representative and suitable for geochemistry and whole rock Ar-Ar dating. Sample -6 through -9 are chilled margins with fresh glass.

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR61-1	1. Rock Type: volcanic, aphyric lava with 0.5cm flow banding structure / layers. Slightly altered, dense trachyte? 2. Size: 17x11x10cm 3. Shape / Angularity: subangular 4. Color of cut surface: greyish - brown 5. Texture / Vesicularity: dense, flow banding, very minor vesicles <<0.5%, occassional Mn filling 6. Phenocrysts: none 7. Matrix: fine grained, abundant Fsp laths <1mm and Px in groundmass 8. Secondary Minerals: 1cm oxidation halo along margin of sample 9. Encrustations: Mn coating << 0.5mm 10. Comment: fairly fresh trachytic lava, aphyric, good for geochemistry and groundmass Ar-Ar dating	x	x						
SO258-DR61-2	1. Rock Type: volcanic, aphyric lava similar to -1, appears a bit fresher, ~1% vesicles 2. Size: 8x10x10cm 3. Shape / Angularity: subangular 4. Color of cut surface: light grey to brownish 5. Texture / Vesicularity: dense, <0.5% <1mm vesicles mostly open, some lined with FeOH, some filled with Cc or zeoliths 6. Phenocrysts: none 7. Matrix: fine grained, fresh Fsp laths ~1mm in groundmass, irregularly distributed 8. Secondary Minerals: minor Fe staining along cracks 10. Comment: similar to -1, overall a bit less altered, good for geochemistry and whole rock Ar-Ar dating	x	x					GC in airfreight box	
SO258-DR61-3	1. Rock Type: volcanic, aphyric lava similar to -1 & -2, but more coarse grained, slightly to moderately altered 2. Size: 12x9x6cm 3. Shape / Angularity: subangular 4. Color of cut surface: greyish - brown 5. Texture / Vesicularity: dense, more vesicles than -2 bit smaller, overall volume <1%, mostly open 6. Phenocrysts: none 7. Matrix: medium grained, fresh Fsp laths ~1.2mm in groundmass 8. Secondary Minerals: some larger vugs ø 1cm filled with yellowish material 10. Comment: overall similar to -1 and -2 but more coarse grained, still good for geochemistry	x	x						

Appendix 2 (Station Details and Rock Description)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR61-4	1. Rock Type: volcanic, aphyric lava similar to -1 through -3, moderately altered 2. Size: 8x6x6cm 3. Shape / Angularity: subangular 4. Color of cut surface: light brown with fresh greyish areas 5. Texture / Vesicularity: dense, ~ 1% up to 2mm, filled 6. Phenocrysts: none 7. Matrix: medium grained, fresh Fsp laths ~1.2mm in groundmass 8. Secondary Minerals: some larger vugs ø 1cm filled with yellowish material 10. Comment: GC slabs have very minor areas of fresh grey rock which should be preferentially picked if possible	x	x						
SO258-DR61-5	1. Rock Type: volcanic, aphyric lava similar to prev. samples but more oxidized and with less Fsp in groundmass 2. Size: 7x5x6cm 3. Shape / Angularity: 4. Color of cut surface: greyish - purple 5. Texture / Vesicularity: dense, <1% filled with FeOH 6. Phenocrysts: none 7. Matrix: fine grained, less Fsp laths in groundmass, fresh 8. Secondary Minerals: overall groundmass more oxidized 10. Comment: still ok for geochemistry, Ar-Ar dating questionable	x	x						
SO258-DR61-6	1. Rock Type: volcanic, chilled margin with fresh glass and red palagonite 2. Size: 6x6x4cm 3. Shape / Angularity: angular 4. Color of cut surface: glass = black, altered crystallized matrix = brown, palagonite = red-orange 5. Texture / Vesicularity: glass = dense, lots of fractures parallel to margin and filled with Cc, very few vesicles in glass 6. Phenocrysts: none 7. Matrix: crystallized matrix dense, brown, oxidized 10. Comment: fresh glass, quality and amount good for spot and bulk analysis				GL				
SO258-DR61-7	1. Rock Type: volcanic, chilled margin with fresh glass, similar to -6 but very thick 1-2cm chilled margin 2. Size: 6x6x3cm 3. Shape / Angularity: angular 10. Comment: thickest chilled margin of dredge				GL				
SO258-DR61-8	1. Rock Type: volcanic, chilled margin with fresh glass, similar to -7 2. Size: 5x3x3cm 3. Shape / Angularity: angular 10. Comment: overall identical to -7, fresh glass <5mm thick above 1-2cm chilled zone				GL				

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR61-9	1. Rock Type: volcanic, chilled margin with possible fresh glass 2. Size: 8x7x4cm 3. Shape / Angularity: angular 8. Secondary Minerals: abundant cracks filled with Cc 10. Comment: may contain fresh glass, chilled black zone still good for geochemistry				GL				
SO258-DR61-10	1. Rock Type: volcanic, aphyric lava similar to -1 through -5 but more altered / oxidized and vesicular, less Fsp in groundmass 2. Size: 13x11x11cm 4. Color of cut surface: redish brown to grey patchy 5. Texture / Vesicularity: dense, <5% up to 1.5mm, some open some filled 6. Phenocrysts: Fsp ø2mm <0.5% slightly altered 7. Matrix: fine to medium grained, Fsp laths altered 8. Secondary Minerals: overall more oxidized groundmass 9. Encrustations: thin Mn coating 10. Comment: maybe good for GC, Ar-Ar questionable	x	x						
SO258-DR61-11	1. Rock Type: volcanic, aphyric lava similar to -1 through -5, moderatley altered 2. Size: 10x7x4cm 4. Color of cut surface: grey to slightly brownish 5. Texture / Vesicularity: dense, <1% up to 1mm, mostly open or lined, some filled with FeOH 6. Phenocrysts: Fsp very rare <0.5% 1-2mm 7. Matrix: fine grained, few, fresh Fsp laths in groundmass, Px 10. Comment: in contrast to aphyric -1 and -5 very few Fsp phenocrysts	x	x						
SO258-DR61-12	1. Rock Type: volcanic, aphyric lava fragment, slightly vesicular, more Px less Fsp than in prev. samples, slightly to moderately altered 2. Size: 7x8x4cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey 5. Texture / Vesicularity: vesicular, <5% <1.5mm, mostly open, some filled with FeOH 6. Phenocrysts: none 7. Matrix: medium grained, Px cluster, less Fsp than in -1 through -5 10. Comment: appears different from prev. samples by having more Px, overall good for geochemistry, possibly good for Ar-Ar	x	x					GC in airfreight box	
SO258-DR61-13	1. Rock Type: volcanic, aphyric lava fragment, similar to -1 through -5 2. Size: 6x7x6cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey, one part with black zone which could be chilled margin without glass 5. Texture / Vesicularity: vesicular, <5% <1.5mm, mostly open, some filled with FeOH 10. Comment: overall very similar to -1 through -5, good for GC and Ar-Ar	x	x						

Appendix 2 (Station Details and Rock Description)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR61-14	1. Rock Type: volcanic, aphyric lava fragment, similar to -1 through -5 2. Size: 9x5x3cm 10. Comment: see -13	x	x						
SO258-DR61-15	1. Rock Type: volcanic, aphyric lava fragment, indentical to -14 2. Size: 8x5x4cm 10. Comment: see prev. samples	x	x						
SO258-DR61-16	1. Rock Type: volcanic, aphyric lava fragment, indentical to -13 to -16 2. Size: 8x5x3cm 10. Comment: see prev. samples	x	x						
SO258-DR61-17	1. Rock Type: volcanic, aphyric lava fragment, similar to -1 to -5 2. Size: 2x6x6cm 4. Color of cut surface: greyish to slightly brown 5. Texture / Vesicularity: dense <3% vesicles filled with Cc 7. Matrix: fine to medium grained 10. Comment: ok for GC, Ar-Ar questionable	x	x						
SO258-DR61-18	1. Rock Type: volcanic, aphyric lava fragment, similar to -1 to -5 but more strongly altered with 1cm alteration halo 2. Size: 8x9x6cm 3. Shape / Angularity: 4. Color of cut surface: grey to brownish, black alteration halo 5. Texture / Vesicularity: 6. Phenocrysts: 7. Matrix: 8. Secondary Minerals: 9. Encrustations: 10. Comment: overall similar to prev samples but more altered, GC + Ar-Ar questionable	x	x						

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR61-19	1. Rock Type: strongly altered hyaloclastite 2. Size: 17x13x13cm 4. Color of cut surface: greenish yellow 5. Texture / Vesicularity: contains a 2-3 cm ø vesicular basalts clast with 3mm Fsp phenocrysts: 10. Comment: basalt clast could be interesting fro dating and GC but difficult to prepare	x	x basaltic clast !						
SO258-DR61-20	1. Rock Type: sediment, semi-consolidated mudstone 2. Size: 20x18x7cm 4. Color of cut surface: light brown 10. Comment: may contain fossils for biostratigraphy								
SO258-DR61-21	1. Rock Type: sediment, light colored mudstone or carbonate, very ligh and less dense than -20 2. Size: 11x7x6cm 3. Shape / Angularity: subrounded 10. Comment: may contain fossils for biostratigraphy								

SO258-DR65

Description of Location and Structure: Afanasy Nikitin Complex, Northern section, Seamount at the western footwall of Afanasy Nikitin Seamount

Dredge on bottom UTC 02/07/17 06:35 hrs, lat 3°2.73'S, long 83°0.95'E, depth 2690m
Dredge off bottom UTC 02/07/17 07:53 hrs, lat 3°2.99'S, long 83°1.22'E, depth 2280m
total volume: few rocks
Comments: two large, up to 40cm, lava blocks and few small fragments. Homogeneous Ol-Plg basalt, vesicular, sample -1 has fresh glass in chilled margin

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR65-1	1. Rock Type: volcanic, Ol-Plg phyric basalt, slightly altered 2. Size: part of block B; 39x32x18cm original size 3. Shape / Angularity: subangular 4. Color of cut surface: dark brownish grey 5. Texture / Vesicularity: vesicular, amount of vesicles varies from 30 to 10%. Some are large up to 4cm ø flattened. Secondary minerals in vesicles form incrustations on their walls 6. Phenocrysts: Plg 5-7% up to 0.7cm on long side, fresh; Ol ~5% up to 1mm altered to Fe-oxides 7. Matrix: fine crystallized, ~fresh; glass fragments / spots along outer margin 8. Secondary Minerals: white fillings (clay) in vesicles, lining of vesicle walls, Fe-oxide, clay and thin Mn coating 10. Comment: good for geochemistry and and Ar-Ar dating, fresh glass	x	x		GL			GC in airfreight box	

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR65-2	1. Rock Type: volcanic, Ol-Plg phyric basalt, similar to -1 2. Size: part of block A; 30x20x12cm original size 10. Comment: no glass	x	x					see -1	
SO258-DR65-3	1. Rock Type: volcanic, Ol-Plg phyric basalt, similar to -1 2. Size: 18x11x15cm 10. Comment: no glass	x	x					see -1	

SO258-DR68

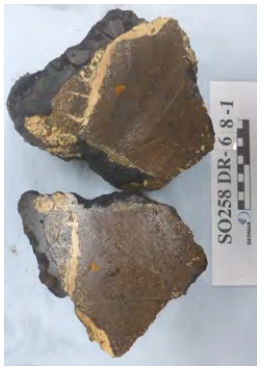
Description of Location and Structure: Afanasy Nikitin Complex, Northern area, small cone E of ±flat, circular plateau; NW flank from middle part to top

Dredge on bottom UTC 02/07/17 21:57 hrs, lat 2°42.04'S, long 82°49.53'E, depth 3077m

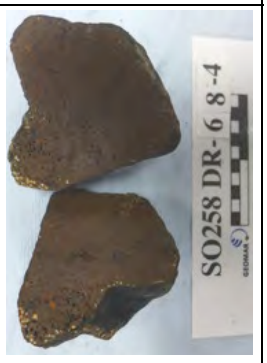
Dredge off bottom UTC 02/07/17 23:38 hrs, lat 2°42.48'S, long 82°49.77'E, depth 2637m

total volume: full

Comments: lots of Mn crust, some embedding hyaloclastite, few loose lava fragments with cm thick Mn crust. All lava fragments are highly vesicular Ol-basalt, strongly altered. Some rare large 0.7mm -10mm megacrysts of Ol contain large 0.2-0.3 Cr-spinel inclusions

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR68-1	1. Rock Type: volcanic, Ol-phyric basalt, strongly altered 2. Size: 19x13x14cm 3. Shape / Angularity: subrounded 4. Color of cut surface: brown with red dots of oxidized Ol 5. Texture / Vesicularity: vesicular, 50% up to 5mm mostly 1mm and less Mn encrustation, white fillings 6. Phenocrysts: Ol 20-30% altered to Fe-hydroxides 0.5-1mm, rarely up to 5mm 7. Matrix: fine crystallized, hyalopilitic, altered, some Plg microliths maybe fresh 8. Secondary Minerals: Mn pervasive or spots and film on vesicle walls 10. Comment: clast from breccia / hyaloclastite covered with up to 20cm Mn crust. The rock is strongly altered, geochemistry is difficult, large Cr-spinel crystals in large Ol phenocrysts	x	x		Cr-Spinel				
SO258-DR68-2	1. Rock Type: volcanic, Ol-phyric basalt, strongly altered, similar to -1 2. Size: 20x13x11cm 3. Shape / Angularity: pillow fragment strongly altered 4. Color of cut surface: brown with red dots of oxidized Ol 5. Texture / Vesicularity: some parts are less vesicular and may be better for geochemistry 10. Comment: large (0.2-0.3mm) Cr-spinel crystals in large Ol phenocrysts	x	x		Cr-Spinel			GC in airfreight box	

Appendix 2 (Station Details and Rock Description)

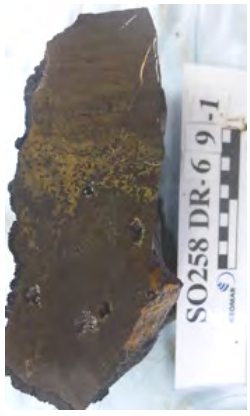
SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR68-3	1. Rock Type: volcanic, Ol-phyric basalt, strongly altered, similar to -1 2. Size: 15x8x8cm 10. Comment: fresh Cr-spinel inclusions in large Ol phenocrysts	x	x		Cr-Spinel				
SO258-DR68-4	1. Rock Type: volcanic, Ol-phyric basalt, strongly altered, similar to -1 2. Size: 13x8x7cm 10. Comment: strongly altered but Plg microphenocrysts are fresh and can be separated for Ar-Ar dating?	x	x		Plg microphenocrysts				
SO258-DR68-5	1. Rock Type: volcanic, Ol-phyric basalt, highly vesicular >50%, marginal part of pillow lava 2. Size: 9x10x8cm 10. Comment: strongly altered, encrustation in vesicles. Not good for geochemistry, though groundmass is relatively fresh	x	x						
SO258-DR68-6	1. Rock Type: volcanic, Ol-phyric basalt, highly vesicular >50%, similar to -5 2. Size: 11x7x7cm 10. Comment: very strongly altered, abundant vesicles make geochemistry difficult / unlikely for this rock	x	x						
SO258-DR68-7	1. Rock Type: volcanic, hyaloclastite with fragements of vesicular Ol-basalt 2. Size: 20x15x10cm 10. Comment: pervasively altered, basalt fragments are similar to -5; ~2cm Mn crust was partly removed during preparation								

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR68-8	1. Rock Type: volcanic, hyaloclastite, strongly altered 2. Size: part of block A; 43x23x24cm original size 10. Comment: similar to -7 but clast (<2cm) are are smaller								
SO258-DR68-9	1. Rock Type: Mn crust 2. Size: 28x11x10cm original size 9. Encrustations: massive Mn crust 4cm in upper part, mixed with clay in lower 2cm part								

SO258-DR69

Description of Location and Structure: Afanasy Nikitin Complex, Northern area, plateau like structure at NW margin, NW slope of plateau edge beneath a small cone

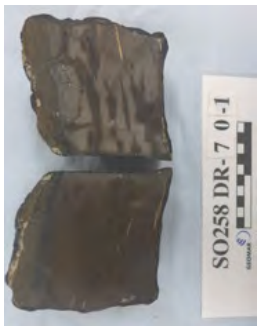
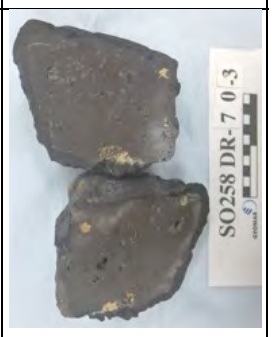
Dredge on bottom UTC 03/07/17 03:42 hrs, lat 2°38.55'S, long 82°43.19'E, depth 3272m
Dredge off bottom UTC 02/07/17 23:38 hrs, lat 2°42.48'S, long 82°49.77'E, depth 2637m
total volume: one rock
Comments: large block of Ol-phyric basalt

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR69-1	1. Rock Type: volcanic, Ol-phyric basalt, transition from glassy to more crystallized parts, rel. fresh matrix, Mn coating 2. Size: 31x21x11cm 3. Shape / Angularity: angular 4. Color of cut surface: crystallized part is dark grey, more glassy part greenish with black crystalline basaltic clusters / droplets, glassy part greenish to grey 5. Texture / Vesicularity: <5% vesicles, some very large up to 3cm 6. Phenocrysts: Ol 10% 3mm, altered to red-orange Fe-oxide 7. Matrix: fresh Plg in matrix. There is a gradation from high degree of crystallization to transitional to glassy. Crystallized layer: 8cm thick with large vesicles. Transitional part: clusters of crystals getting smaller towards glassy section of the rock (7.5cm), smaller vesicles and few bif vesicles; glassy section: 6.5cm seems to have layering <2% very small vesicles 8. Secondary Minerals: vesicles partly filled with white minerals 9. Encrustations: Mn coating 0.5 cm 10. Comment: two different parts prepared for GC slab from more crystallized and glassy sections	x	x two pieces glassy and crystallized					GC in airfreight box	

SO258-DR70

Description of Location and Structure: Afanasy Nikitin Complex, NW tip, small cone at the base of the western flank

Dredge on bottom UTC 03/07/17 10:09 hrs, lat 2°24.91'S, long 82°35.67'E, depth 4073m
Dredge off bottom UTC 03/07/17 11:27 hrs, lat 2°25.23'S, long 82°35.90'E, depth 3660m
total volume: few rocks
Comments: three different lava types recovered. 1) more evolved, more viscous lava (-1) with altered Fsp but overall only slightly altered groundmass; 2) Ol-Px±Plg phyric lava (-2, -6 and -7); contains most notably large mm sized, fresh Px but Fsp appears altered; 3) aphyric lava (-3, -4, -5) recovered from breccia, moderately altered with Ol / Px in groundmass.

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR70-1	1. Rock Type: volcanic, lava fragment with chilled zone (no fresh glass), slightly altered, several cm elongated vesicles parallel to margin reflect high viscosity of melt; more evolved, trachytic? 2. Size: 12x10x10cm 3. Shape / Angularity: subangular 4. Color of cut surface: dark grey to slightly brownish 5. Texture / Vesicularity: vesicular, 5% very elongated up to 5cm long and 2-3mm wide, mostly open, abundant smaller vesicles 10-15% <0.1mm some open some filled with light brown material 6. Phenocrysts: altered Fsp 2-3% up to 4mm elongated parallel to vesicles = flow texture; Ol <1% 1-2mm altered 7. Matrix: medium grained, looks like particles were baked together 8. Secondary Minerals: some vesicles filled with white material, also in fractures 10. Comment: basically ok for geochemistry but requires selective picking, Ar-Ar dating on groundmass free of filled micro vesicles	x	x					GC in airfreight box	
SO258-DR70-2	1. Rock Type: volcanic, Ol-Px±Plg phyric lava fragment, fairly fresh to slightly altered 2. Size: 17x9x8cm 3. Shape / Angularity: subangular 4. Color of cut surface: dark grey to slightly brownish 5. Texture / Vesicularity: vesicular, 7% 5-2mm, mostly open 6. Phenocrysts: Ol 1-2% <1mm altered, Px 5% 1-2mm fresh, Fsp-megacrysts <<1% 5-7mm altered, lots of smaller Fsp 2-3% <0.4mm altered 7. Matrix: medium crystallized 8. Secondary Minerals: some clay fillings of vesicles 10. Comment: basically good for geochemistry; Px may be separated for isotope analysis, Ar-Ar questionable as Fsp appears altered throughout	x	x		Px			GC in airfreight box	
SO258-DR70-3	1. Rock Type: volcanic, aphyric lava fragment, recovered as clast from breccia block A, moderately altered 2. Size: 14x10x10cm 3. Shape / Angularity: subrounded 4. Color of cut surface: light grey to slightly brownish 5. Texture / Vesicularity: vesicular, 5% 1-4mm, mostly open, some filled with yellowish material / clay 6. Phenocrysts: none 7. Matrix: medium crystallized <1% Ol altered and Px 1-2% in groundmass 8. Secondary Minerals: fillings of vesicles and cracks 9. Encrustations: 10. Comment: good for geochemistry, aphyric in contrast to -2 and -6, Ar-Ar maybe possible on matrix after TS inspection	x	x						

Appendix 2 (Station Details and Rock Description)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR70-4	1. Rock Type: volcanic, aphyric lava fragment, recovered as clast from breccia block A, moderately altered 2. Size: 13x9x10cm 10. Comment: similar to -3 but vesicles more filled with yellowish material	x	x						
SO258-DR70-5	1. Rock Type: volcanic, aphyric lava fragment, recovered as clast from breccia block A, moderately altered 2. Size: 14x10x10cm 10. Comment: similar to -3	x	x						
SO258-DR70-6	1. Rock Type: volcanic, Ol-Px phyric lava fragment, strongly altered, somewhat similar to -2 2. Size: 7x7x5cm 3. Shape / Angularity: rounded 4. Color of cut surface: greyish - black 5. Texture / Vesicularity: vesicular, 7% large vesicles 1-3mm ø, mostly open but lined with secondaries, lots of very small vesicles 2-3% <0.3mm filled with white material but this could also be altered Fsp, can be scratched with needle and is roundish 6. Phenocrysts: Ol 1% <2mm altered to Fe-oxide, Px 1-2% 2-3mm fresh, possibly altered Fsp microphenocrysts ---> see vesicles 7. Matrix: coarse crystalline groundmass 8. Secondary Minerals: Fe-oxide after Ol 9. Encrustations: Mn patches on outside 10. Comment: As in -2 notably abundant (1-2%) fresh Px which may be used for geochemistry. TS to be checked if Fsp microphenocrysts or filled vesicles								
SO258-DR70-7	1. Rock Type: volcanic, Ol-Px phyric lava fragment or tuff?, moderately altered 2. Size: 7x5x3cm 3. Shape / Angularity: rounded 4. Color of cut surface: black 5. Texture / Vesicularity: dense 6. Phenocrysts: Ol <1% <1mm altered to Fe-oxide, Px 1% 2mm fresh 7. Matrix: coarse crystalline groundmass consists of sub mm sized spheres which give rock an appearance of amalgamation of different matrials: fragmented melt drops + Px + Ol 10. Comment: not quite clear what this rock represents								

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR70-8	1. Rock Type: Mn crust 2. Size: 7x5x4cm 3. Shape / Angularity: 4. Color of cut surface: black 5. Texture / Vesicularity: dense 9. Encrustations: 3cm thick Mn crust								

SO258-DR72

Description of Location and Structure: Work Area D, SE corner with a S-shaped fracture zone - abyssal hill structure. Origin of E-W striking S-shaped abyssal hill that is bend in the middle due to displacement along fracture zone? or overlapping spreading center? is unclear. SE facing slope, oblique to slope due to wind and current directions (170° to 250° possible)

Dredge on bottom UTC 04/07/17 21:06 hrs, lat 2°7.15'N, long 86°5.94'E, depth 4073m
Dredge off bottom UTC 04/07/17 23:45 hrs, lat 2°6.98'N, long 86°5.47'E, depth 3777m
total volume: 1/6 full
Comments: volcanics along with deep sea mud. Z(-339)S

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR72-1	1. Rock Type: volcanic, rare Bi-Cpx-Plg phyric trachyte (?), fairly fresh 2. Size: 26x20x13cm 3. Shape / Angularity: subangular 4. Color of cut surface: brown with dark bands 5. Texture / Vesicularity: highly vesicular, 50-60% large up to 1cm and elongated plus very tiny vesicles 6. Phenocrysts: Plg ~2-3% 1-3mm fresh; Bi ~1-2% up to 5mm fresh (?), Cpx ~1-2% ~0.2-0.3mm dark green fresh; Ilm (?) ~1% 0.2-0.3mm 7. Matrix: highly vesicular, leucocratic, fine crystallized, small Plg and Bi crystals 8. Secondary Minerals: some linings / encrustations inside vesicles (Mn, mud) 9. Encrustations: very thin outer film of Mn oxides; altered hyaloclastite attached 10. Comment: the rock looks rel. evolved and leucocratic groundmass is somewhat oxidized. Ar-Ar feasible on Bi and possibly Plg	x	x		Bi, Plg, Cpx, Ilm			GC in airfreight box	
SO258-DR72-2	1. Rock Type: volcanic, rare Bi-Cpx-Plg phyric trachyte (?), fairly fresh, similar to -1 but likely less oxidized 2. Size: 21x14x6cm 10. Comment: good for geochemistry and Ar-Ar dating	x	x		Bi, Plg, Cpx, Ilm			see -1	

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR72-3	1. Rock Type: volcanic, rare Bi-Cpx-Plg phyric trachyte (?), fairly fresh, similar to -1 but has more dense texture and rounded vesicles. Perhaps more quickly cooled 2. Size: 13x10x12cm 10. Comment: good for geochemistry and Ar-Ar dating	x	x		Bi, Plg, Cpx, Ilm			see -1	
SO258-DR72-4	1. Rock Type: volcanic, rare Bi-Cpx-Plg phyric trachyte (?), similar to -1. Vesicles are highly elongated and flattened, somewhat less oxidized 2. Size: 16x15x15cm 10. Comment: good for geochemistry and Ar-Ar dating	x	x		Bi, Plg, Cpx			see -1	
SO258-DR72-5	1. Rock Type: volcanic, rare Bi-Cpx-Plg phyric trachyte (?), similar to -1 2. Size: 16x15x10cm 10. Comment: good for geochemistry and Ar-Ar dating	x	x		Bi, Plg, Cpx			see -1	
SO258-DR72-6	1. Rock Type: volcanic, rare Bi-Cpx-Plg phyric trachyte (?), similar to -1. Vesicles are well rounded and have uneven surfaces 2. Size: 15x10x13cm 10. Comment: good for geochemistry and Ar-Ar dating	x	x		Bi, Plg, Cpx			see -1	
SO258-DR72-7	1. Rock Type: volcanic, rare Bi-Cpx-Plg phyric rock, mostly glass, rounded fragment from hyaloclastite 2. Size: 12x19x7cm 3. Shape / Angularity: rounded 4. Color of cut surface: dark grey with red bands 5. Texture / Vesicularity: massive, glassy 6. Phenocrysts: identical to -1 7. Matrix: glassy, partly palagonitized 8. Secondary Minerals: outer part more altered to light green , red partly oxidized, fine grained stuff 10. Comment: glass is fresh + minerals. Glass sample in glass bag is small split, most glass in main bag!				Bi + GL				

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR72-8	1. Rock Type: volcanic, glassy fragment, similar to -7 2. Size: 7x7x5cm				GI				
SO258-DR72-9	1. Rock Type: volcanic, glassy fragment of Bi-Cpx-Plg trachyte (?), similar to -7 but its margin is of more crystallized lava. Glass in spots surrounded by palagonite. 2. Size: 8x6x6cm 10. Comment: glass well preserved, looks like marginal part				GI				
SO258-DR72-10	1. Rock Type: volcanic, glassy fragment, similar to -9 2. Size: 8x5x5cm 10. Comment: very well preserved glass				GI				
SO258-DR72-11	1. Rock Type: volcanic, glassy fragment, similar to -9 2. Size: 6x5x4cm 10. Comment: very well preserved glass				GI				
SO258-DR72-12	1. Rock Type: volcanic, glassy fragment, similar to -7 2. Size: 7x4x4cm 10. Comment: small glass eggs				GI				
SO258-DR72-13	1. Rock Type: volcanic, glassy fragment, similar to -7 2. Size: 7x5x4cm				GI				

Appendix 2 (Station Details and Rock Description)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR72-14	1. Rock Type: volcanic, glassy fragment, similar to -7 2. Size: 8x5x4cm				Gl				
SO258-DR72-15	1. Rock Type: volcanic, glassy fragment, similar to -7 2. Size: 5x5x4cm				Gl				
SO258-DR72-16	1. Rock Type: volcanic, glassy fragment, similar to -7 2. Size: 6x4x4cm				Gl				
SO258-DR72-17	1. Rock Type: volcanic, Ol-Plg phyric basalt, moderately altered 2. Size: 10x9x5cm 3. Shape / Angularity: 4. Color of cut surface: light browm to grey 5. Texture / Vesicularity: slightly vesicular, porphyric 6. Phenocrysts: Plg 5% 1-2mm fresh; Ol ~2-3% 0.5-1mm altered to Fe oxides 7. Matrix: glass in outer margin, microcrystalline in inner part 8. Secondary Minerals: oxidation, palagonite after glass, Mn veins 10. Comment: glass is fresh and rel. abundant, whole geochemistry ok, Ar-Ar on glass, Plg?	x	x	Gl, Plg	Gl				
SO258-DR72-18	1. Rock Type: volcanic, Ol-Plg phyric basalt, similar to -17 2. Size: 9x7x5cm 8. Secondary Minerals: Mn in vesicles and veins	x	x				see -17	GC in airfreight box	

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR72-19	1. Rock Type: volcanic, aphyric basalt, moderately altered 2. Size: 8x6x6cm 4. Color of cut surface: light brownish grey 5. Texture / Vesicularity: 10% 7. Matrix: fine grained groundmass 8. Secondary Minerals: Mn precipitation on vesicle walls and along cracks 10. Comment: good for geochemistry, some picking and washing to remove mud from voids required	x	x						
SO258-DR72-20	1. Rock Type: volcanic, aphyric basalt, similar to -19 but has some ~2% 1mm altered Ol phenocrysts 2. Size: 6x4x6cm 5. Texture / Vesicularity: filled 10. Comment: not very good for geochemistry	x	x						
SO258-DR72-21	1. Rock Type: volcanic, rare Ol-Plg phyric basalt, similar to -17 2. Size: 10x6x8cm 5. Texture / Vesicularity: filled 8. Secondary Minerals: Mn filling of small vesicles 10. Comment: ok for geochemistry	x	x					see -17	
SO258-DR72-22	1. Rock Type: volcanic, rare Bi-Plg-Cpx phyric trachyte (?), similar to -1 but has dense massive texture with rare vesicles 2. Size: 8x6x5cm 10. Comment: looks very good for geochemistry, looks very fresh, small sample	x	x	x					
SO258-DR72-23X	1. Rock Type: archive samples of Bi-Cpx-Pl trachytes 2. Size: 17x17x10cm 10. Comment: archive							archive	
SO258-DR72-24X	1. Rock Type: archive samples of Bi-Cpx-Pl trachytes 2. Size: 16x14x11cm 10. Comment: archive							archive	

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR72-25X	1. Rock Type: archive samples of Bi-Cpx-Pl trachytes 2. Size: 18x18x11cm 10. Comment: archive							archive	
SO258-DR72-26X	1. Rock Type: archive samples of Bi-Cpx-Pl trachytes 2. Size: 15x14x8cm 10. Comment: archive							archive	

SO258-DR73

Description of Location and Structure: Work Area D, partly burried hills, flat topped seamount, northern slope

Dredge on bottom UTC 05/07/17 14:09 hrs, lat 3°26.83'N, long 84°30.49'E, depth 4059m

Dredge off bottom UTC 05/07/17 15:44 hrs, lat 2°26.42'N, long 82°30.27'E, depth 3570m

total volume: two rocks

Comments: Mn crust with two lava fragments of slightly Ol-Fsp phyric basalt, moderately altered (-1A & -1B). Mn encrusted, highly altered volcaniclastic rocks (-2)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR73-1A	1. Rock Type: volcanic, slightly Ol-Plg phyric basalt, recovered from Mn encrusted breccia, slightly to moderately altered 2. Size: Mn breccia block A; 24x21x13cm original size, clast; 11x10x6cm 3. Shape / Angularity: subrounded to rounded 4. Color of cut surface: dark grey to brown 5. Texture / Vesicularity: dense 6. Phenocrysts: Ol ~2% 1-2mm altered; Plg-Px clusters ~1% 1-3mm fresh 7. Matrix: fine grained 8. Secondary Minerals: slight groundmass oxidation, Mn lining & filling along cracks 9. Encrustations: thick 3-4cm Mn crust covering entire clast removed by hammer and saw 10. Comment: good for geochemistry, nature of Plg.Px clusters clusters to be verified for Ar-Ar dating, groundmass probably too altered	x	x					GC in airfreight box	

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR73-1B	1. Rock Type: volcanic, slightly Ol-Plg±Px phyric basalt, recovered from Mn encrusted breccia, overall identical to -1A 2. Size: clast; 6x7x5cm 10. Comment: TS not made to safe volume for GC	TS not made due to volume restrictions	x					GC in airfreight box	
SO258-DR73-2	1. Rock Type: volcaniclastic, Mn encrusted, mm to 1.5cm sized subrounded clasts of lava and altered glass, very strongly altered, not usable for geochemistry 2. Size: 18x12x7cm 3. Shape / Angularity: subrounded 4. Color of cut surface: orange brown 5. Texture / Vesicularity: matrix supported 9. Encrustations: 3cm Mn crust 10. Comment: taken for reference								

SO258-DR74

Description of Location and Structure: Work Area D, partly burried hills, flat topped seamount, western slope. Repeat of DR73, rack oblique to slope due wind and current limitations

Dredge on bottom UTC 05/07/17 19:05 hrs, lat 3°22.99'N, long 84°31.38'E, depth 4078m
Dredge off bottom UTC 05/07/17 20:35 hrs, lat 3°22.75'N, long 84°30.94'E, depth 3709m
total volume: empty

SO258-DR75

Description of Location and Structure: Work Area D, partly burried hills, southern part of NNE-SSW striking ridge, guyot-like structure, northern slope

Dredge on bottom UTC 06/07/17 03:54 hrs, lat 3°57.95'N, long 84°57.97'E, depth 4041m
Dredge off bottom UTC 06/07/17 5:22 hrs, lat 3°57.50'N, long 84°57.95'E, depth 3600m
total volume: very few rocks
Comments: mainly aphyric lava fragments in breccia, moderately altered. -1 contains rare Ol-Plg phenocrysts.

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR75-1	1. Rock Type: volcanic, aphyric, very rare Ol-Plg phyric basalt, moderately altered 2. Size: 4x5x5cm 3. Shape / Angularity: subangular 4. Color of cut surface: brownish grey to black 5. Texture / Vesicularity: massive, no vesicles 6. Phenocrysts: Plg ~1-2% <3mm fresh; Ol <1% <1mm replaced by Fe-oxides 7. Matrix: fine crystallized, ~fresh, slightly fluidal 8. Secondary Minerals: minor oxidation, Mn along cracks 9. Encrustations: thin Mn film <1mm on outer surface 10. Comment: very small sample but should be good for geochemistry, Ar-Ar possible on Plg or matrix	x	x	possible	maybe Plg				

Appendix 2 (Station Details and Rock Description)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR75-2	1. Rock Type: volcanic, aphyric basalt, altered 2. Size: 7x6x4cm 3. Shape / Angularity: subangular clast from breccia 4. Color of cut surface: brownish grey to black 10. Comment: simlar to -1 but more altered to yellowish grey. Freshest part restricted to 0.5cm ø core of sample. It can be measured by LA-ICPMS for major and trace elements. Isotopes if fresh core is carefully extracted	x	x					see -1	
SO258-DR75-3	1. Rock Type: volcanic, aphyric basalt, altered clast in breccia, similar to -2 2. Size: 7x6x5cm 10. Comment: also has a fresh small core which can be used for geochemistry if carefully extracted	x							
SO258-DR75-4	1. Rock Type: volcanic breccia, moderately to strongly altered 2. Size: 8x4x3cm 10. Comment: composed of angular clasts of aphyric, variably vesicular basalt similar to -1 through -3	x							
SO258-DR75-5	1. Rock Type: volcanic breccia, similar to -4 2. Size: 7x4x2cm	x							
SO258-DR75-6	1. Rock Type: sediment, limestone with small clasts of aphyric basalts 2. Size: 12x12x7cm 10. Comment: cut into four pieces, one piece to Oleg Levchenko for paleontology	x						Levchenko	

SO258-DR76

Description of Location and Structure: Work Area D, partly burried hills, NNE-SSW striking ridge, guyot-like structure, northern slope, 1nm E of DR75 upper slope

Dredge on bottom UTC 06/07/17 09:03 hrs, lat 3°58.03'N, long 84°59.09'E, depth 3760m
Dredge off bottom UTC 06/07/17 11:11 hrs, lat 3°57.80'N, long 84°59.07'E, depth 3528m
total volume: few rocks
Comments: fragments of breccia composed of angular fragments of aphyric basalt along with volcaniclastic rocks with glassy fragments in parts, some with fresh cores

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR76-1	1. Rock Type: volcanic, aphyric basalt clast, moderately altered, recovered from breccia 2. Size: 16x13x6cm 3. Shape / Angularity: subangular to rounded 4. Color of cut surface: brownish to grey 5. Texture / Vesicularity: massive, with few cracks, some vesicles, some filled with Cc, some emtpy, <3% <2mm 6. Phenocrysts: none 7. Matrix: fine crystallized, Fsp-Px groundmass 8. Secondary Minerals: Cc in vesicles 9. Encrustations: Mn crust <<2mm, some parts show altered glass crust with lava? fragments or hyaloclastite	x	x					GC in airfreight box	
SO258-DR76-2	1. Rock Type: volcanic, aphyric basalt clast with Mn crust and hyaloclatite attached, moderately altered, recovered from breccia 2. Size: 11x7x5cm 3. Shape / Angularity: subangular 4. Color of cut surface: beige to grey 5. Texture / Vesicularity: massive, few vesicles <3% <1mm open 6. Phenocrysts: none 7. Matrix: fine-medium crystallized, mostly Plg-Px in groundmass, possibly very few Ol 8. Secondary Minerals: Mn along cracks 9. Encrustations: thin Mn crust and some hyaloclastite attached	x	x						
SO258-DR76-3	1. Rock Type: volcanic, aphyric basalt clast, moderately altered, recovered from breccia 2. Size: 9x8x3cm 3. Shape / Angularity: subangular 4. Color of cut surface: black-grey-brown 5. Texture / Vesicularity: massive, many cracks and alteration along them, ~1% <1mm vesicles, nearly no smaller vesicles in groundmass 6. Phenocrysts: none 7. Matrix: fine crystallized, no minerals observable under binocular 8. Secondary Minerals: Cc in vesicles 9. Encrustations: Mn crust <1mm	x							
SO258-DR76-4	1. Rock Type: volcaniclastic, hyaloclastite with aphyric lava fragments, strongly altered 2. Size: 8x6x3cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey to beige, some brown areas 5. Texture / Vesicularity: massive, ~3% <3mm vesicles mostly open 6. Phenocrysts: none 7. Matrix: fine crystallized, Px 40% and Plg 60% in groundmass 8. Secondary Minerals: Cc in some vesicles 9. Encrustations: thin Mn crust <1mm	x							

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR76-5	1. Rock Type: volcanic, aphyric lava clast in Mn encrusted breccia, fairly fresh but with 0.5cm oxidation halo 2. Size: 9x5x4cm 3. Shape / Angularity: angular 4. Color of cut surface: dark grey where groundmass is fresh; oxidized halo brown 5. Texture / Vesicularity: massive, dense, small fractures filled with Mn 6. Phenocrysts: none 7. Matrix: fine crystallized, Px 40% and Plg 60% in groundmass 8. Secondary Minerals: Mn in tiny cracks 9. Encrustations: 2mm Mn crust 10. Comment: taken as backup, one half pretty good for geochemistry, possibly Ar-Ar on matrix	x							
SO258-DR76-6	1. Rock Type: volcaniclastic breccia, altered lava fragments and glass, some contain fresh glassy cores 2. Size: 16x9x6cm 3. Shape / Angularity: subangular 4. Color of cut surface: brown to black where glass is fresh 5. Texture / Vesicularity: massive, dense, aphyric 6. Phenocrysts: none 7. Matrix: fine crystallized 8. Secondary Minerals: white matrix embedding clasts, no reaction with HCl 9. Encrustations: 3-4mm Mn crust 10. Comment: sample has been sliced up to check for fresh glass cores, two slabs saved as GL, rest in main bag				GL two slabs				
SO258-DR76-7	1. Rock Type: volcaniclastic breccia, similar to -6 but more altered, no fresh glass cores visible. Lava fragments also very much oxidized to brown 2. Size: several fragments up to 4cm ø, they were not a single rock 10. Comment: use for geochemistry questionable								

SO258-DR77

Description of Location and Structure: Work Area D, partly burried hills, southern part of NNE-SSW striking ridge, E side of ridge, E facing slope, small nose from base to flat area

Dredge on bottom UTC 06/07/17 15:53 hrs, lat 4°6.76'N, long 85°14.79'E, depth 3971m
Dredge off bottom UTC 06/07/17 16:48 hrs, lat 4°6.55'N, long 85°14.59'E, depth 3736m
total volume: few rocks
Comments: highly altered / oxidized, slightly Plg-Ol phyric lava fragments

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR77-1	1. Rock Type: volcanic, slightly Plg-Ol phyric basalt clast, strongly altered, Plg mircophenocrysts in groundmass 2. Size: 8x6x5cm 3. Shape / Angularity: subangular 4. Color of cut surface: brown 5. Texture / Vesicularity: massive, <1% <<1mm vesicles 6. Phenocrysts: Fsp needles / microphenocrysts <1% <5mm; Ol <1% ~2mm altered 7. Matrix: medium crystallized, many Fsp needles in groundmass <1mm 8. Secondary Minerals: Mn in veins 9. Encrustations: thin Mn crust 10. Comment: Fsp appears fresh	x	x						

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR77-2	1. Rock Type: volcanic, slightly Plg phyric basalt clast, strongly altered, similar to -1 2. Size: 8x6x6cm 3. Shape / Angularity: subangular 4. Color of cut surface: brown 5. Texture / Vesicularity: massive, with many cracks <1% <<1mm vesicles 6. Phenocrysts: Plg ~1% <5mm; Ol <1% ~2mm altered 7. Matrix: medium crystallized, Fsp needles in groundmass <1mm, altered Ol in groundmass 8. Secondary Minerals: Mn in veins 10. Comment: Fsp appears fresh	x	x						
SO258-DR77-3	1. Rock Type: volcanic, slightly Plg phyric basalt clast, strongly altered, similar to -1 2. Size: 9x7x5cm 3. Shape / Angularity: subangular 4. Color of cut surface: brown 5. Texture / Vesicularity: massive, many cracks, <1% <<1mm vesicles 6. Phenocrysts: Plg <1% <4mm altered 7. Matrix: medium crystallized, Fsp needles in groundmass <1mm fresh, altered Ol in groundmass 8. Secondary Minerals: Mn in veins 10. Comment: Fsp appears fresh	x	x						
SO258-DR77-4	1. Rock Type: volcanic, slightly Plg phyric basalt clast, strongly altered, similar to -3 but even more altered 2. Size: 8x7x5cm 3. Shape / Angularity: subangular 4. Color of cut surface: brown 5. Texture / Vesicularity: massive 6. Phenocrysts: Plg <1% <5rmm 7. Matrix: medium crystallized, Fsp needles in groundmass <1mm fresh, altered Ol in groundmass 8. Secondary Minerals: Mn in veins	x	x						

SO258-DR78

Description of Location and Structure: Work Area D, partly burried hills, NNE-SSW striking ridge, E side of ridge, E facing slope from base to top where it flattens, ca 3nm N of DR77

Dredge on bottom UTC 06/07/17 23:08 hrs, lat 4°10.53'N, long 85°14.18'E, depth 3770m
Dredge off bottom UTC 07/07/17 00:25 hrs, lat 4°10.31'N, long 85°13.80'E, depth 3489m
total volume: one rock
Comments: coarse grained aphyric basalt, moderately altered, vesicular

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR78-1	1. Rock Type: volcanic, aphyric basalt clast, moderaltely altered 2. Size: 8x6x5cm 3. Shape / Angularity: subangular 4. Color of cut surface: dark brown - grey 5. Texture / Vesicularity: ~10% 1-3mm rounded vesicles, open 6. Phenocrysts: none 7. Matrix: coarse crystallized, <0.2mm, Ol (altered)+Cpx(±fresh?)-Plg (fresh) 8. Secondary Minerals: alteration affected Ol and likely Cpx, oxidation of groundmass 9. Encrustations: 2cm Mn crust removed during preparation 10. Comment: sample should be ok for geochemistry, Ar-Ar is certainly possible on Plg. Entire sample taken as GC	x	x					GC in airfreight box	

SO258-DR79

Description of Location and Structure: Work Area D, partly burried hills, E slope of seamount E of NNE-SSW striking ridge

Dredge on bottom UTC 07/07/17 06:29 hrs, lat 4°3.78'N, long 85°40.24'E, depth 4115m
Dredge off bottom UTC 07/07/17 07:56 hrs, lat 4°3.73'N, long 85°39.77'E, depth 3850m
total volume: semi-consolidated sediment
Comments:

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO258-DR79-1X	1. Rock Type: sediment, semi-consolidated limestone mud 2. Size: 3. Shape / Angularity: 4. Color of cut surface: 5. Texture / Vesicularity: 6. Phenocrysts: 7. Matrix: 8. Secondary Minerals: 9. Encrustations: 10. Comment: split to Oleg Levchenko	x	x					split to Oleg Levchenko	

Appendix 2 (Station Details and Rock Description)

Abbreviations in Table Header:

TS: thin section billet

CHEM: chemistry slab to prepare materials for geochemical analysis

Ar/Ar: estimate of sample quality for 40Ar/39Ar dating

GL/MIN: potential glass and / or mineral separates

SED: sediment

REF: reference sample for immediate transport to home institution after cruise

Abbreviations for Minerals and Materials:

Fsp: feldspar

Plg: plagioclase

Ol: olivine

Px: pyroxene

CPx: clinopyroxene

Opx: orthopyroxene

Cc: clacite

Mn: manganese

Qtz: Quartz

MI: Melt Inclusions

GM: Groundmass

Mt: Magnetite

Zr: Zircon

Apt: Apatite

Chl: Chlorite

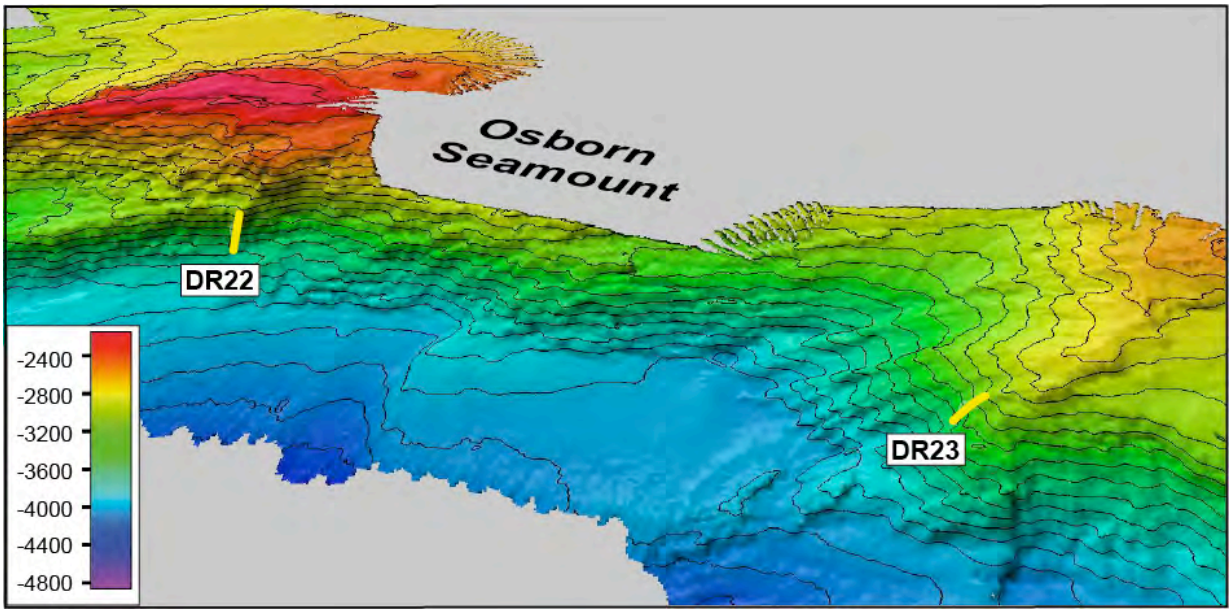
Bi: Biotite

Ilm: Ilmenite

Appendix III (3D Maps of SO258 Leg 1 Dredge Tracks)

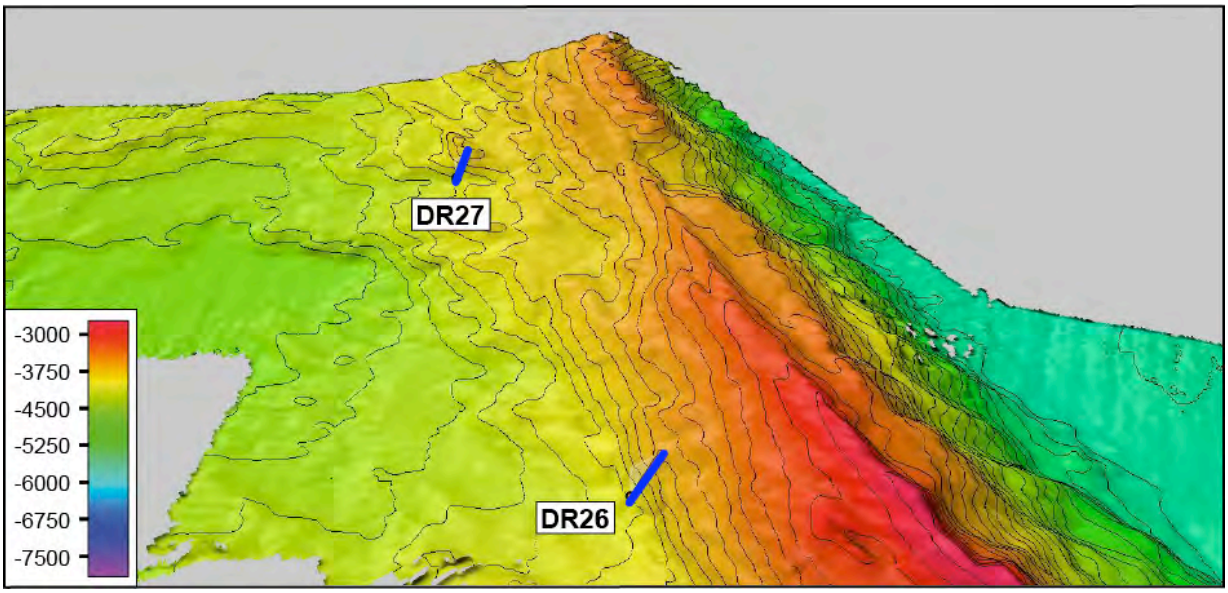
The 3D-maps shown in this appendix are based on multi-beam data recorded on SO258 leg 1. Stereo exaggeration is 2x for all maps, the interval of contour lines is 100 m. The order of the maps and dredge tracks, respectively, corresponds to the dredge site descriptions in chapter 7.1.2.

(A) Dredge sites at Osborn Seamount

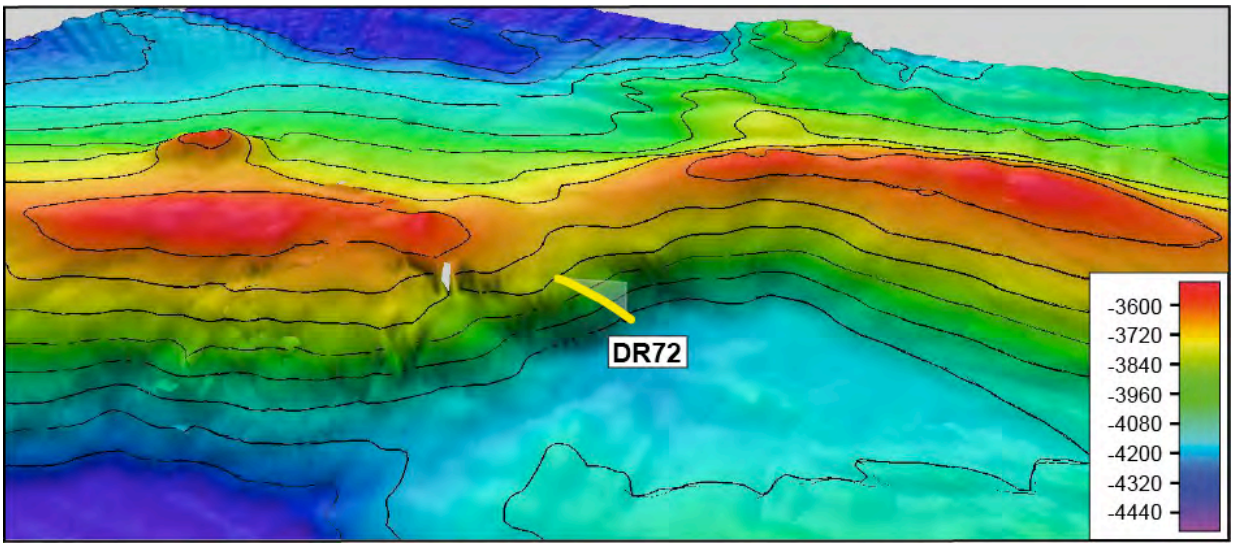


DR22 - 23 at the southern flank of Osborn Seamount (view from S to N).

(B) Dredge sites at the 85° Fracture Zone

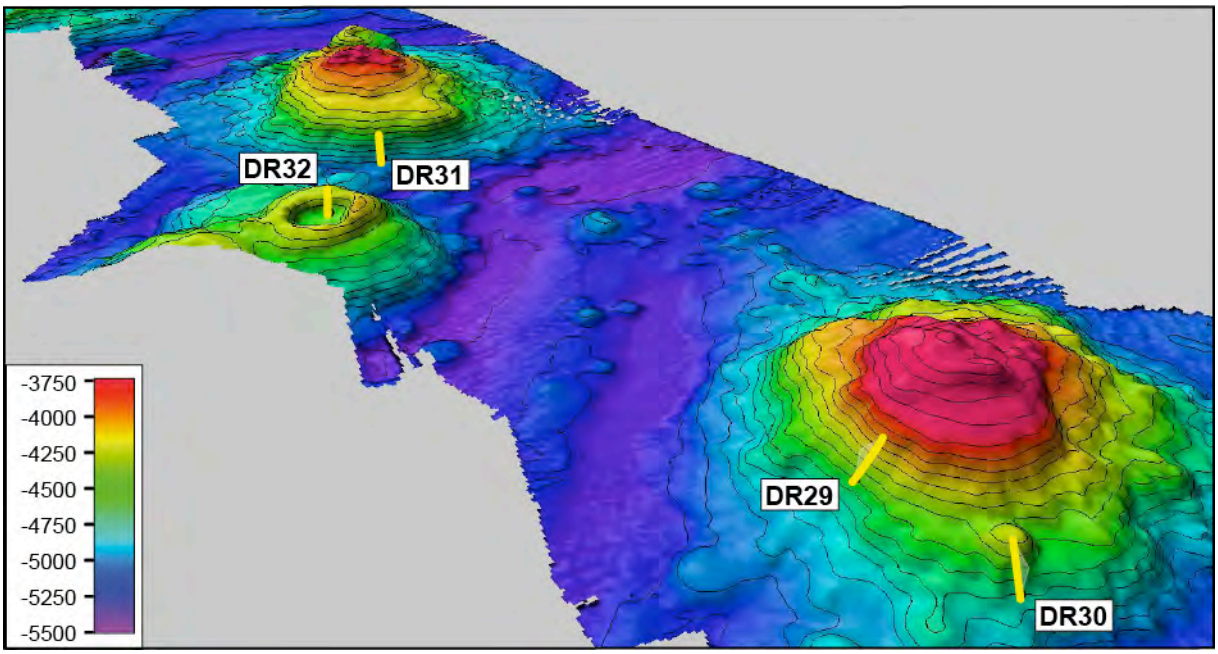


DR26 and 27 at the southern section of the 85° Fracture Zone (view from SW to NE).



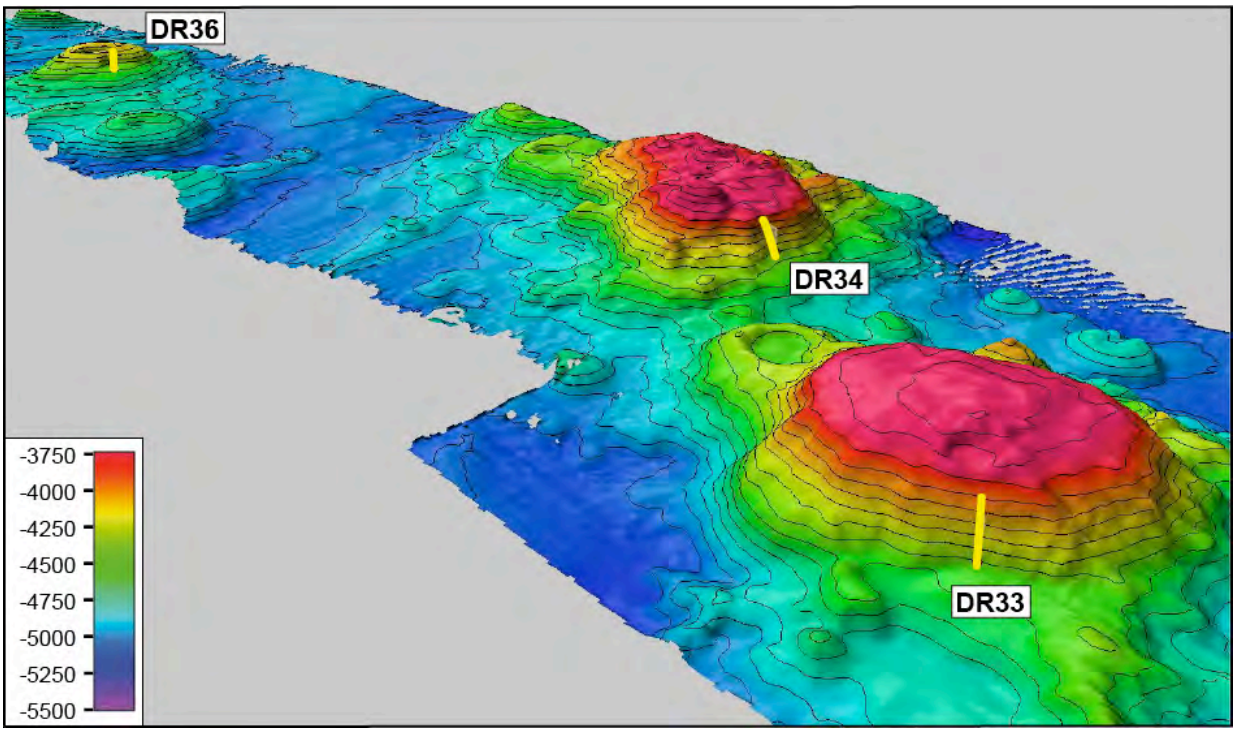
DR72 at an east-west striking abyssal hill on the northern section of the 85° Fracture Zone. The hill has a characteristic S-shape in its center and displaces the eastern branch to the north (view from SSE to NNW).

(C) Dredge sites at the "Southern Seamounts"

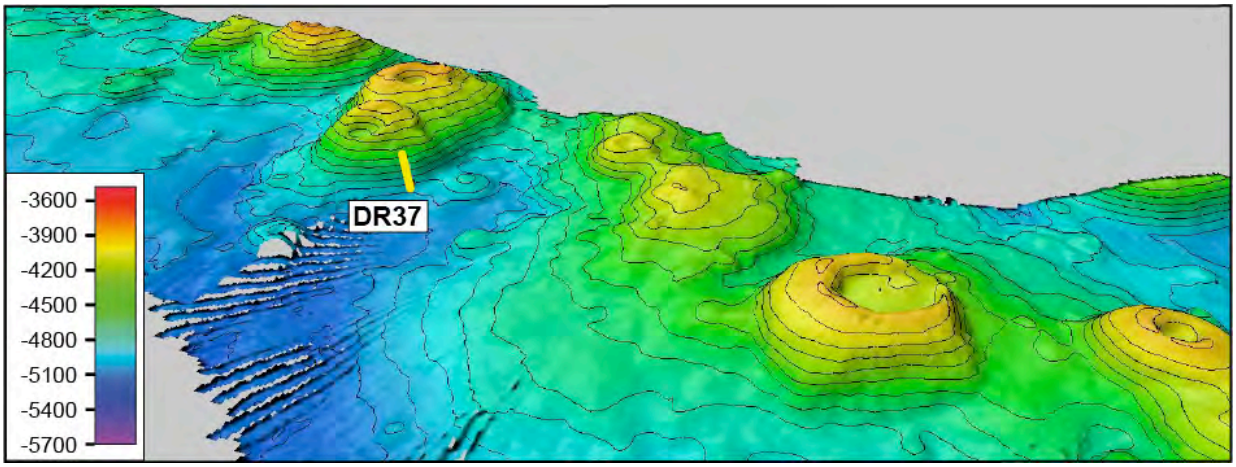


Dredge tracks DR29 - 32 at the southernmost "Southern Seamounts" (view from SW to NE).

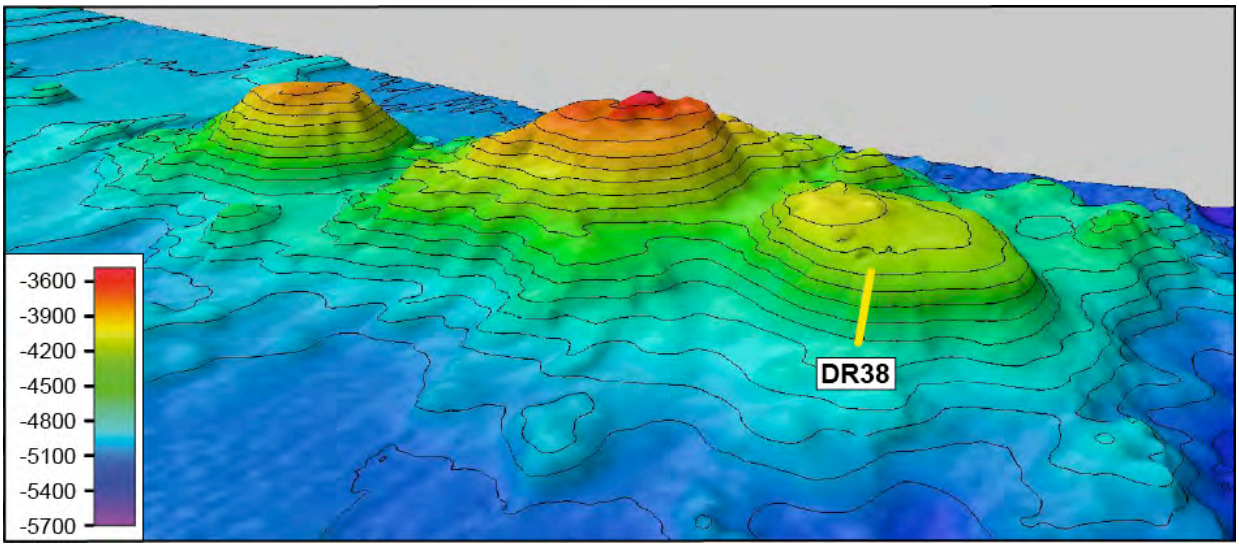
Appendix III (3D Maps of SO258 Leg 1 Dredge Tracks)



The central part of the "Southern Seamounts" with dredge stations DR33, 34, and 36 (view from SW to NE).

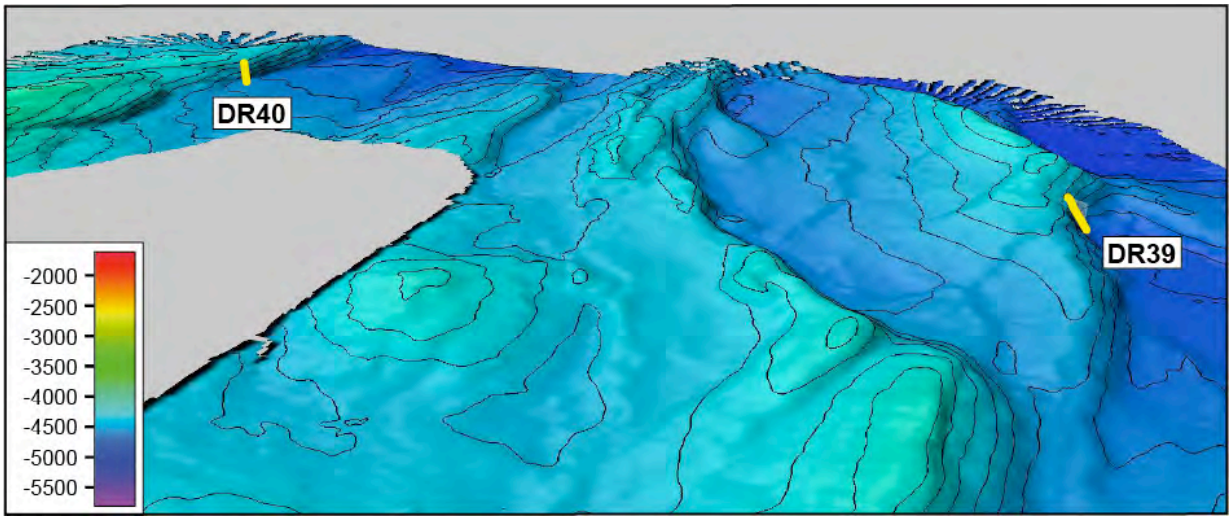


DR37 at one of the northern "Southern Seamounts" (view from WSW to ENE).

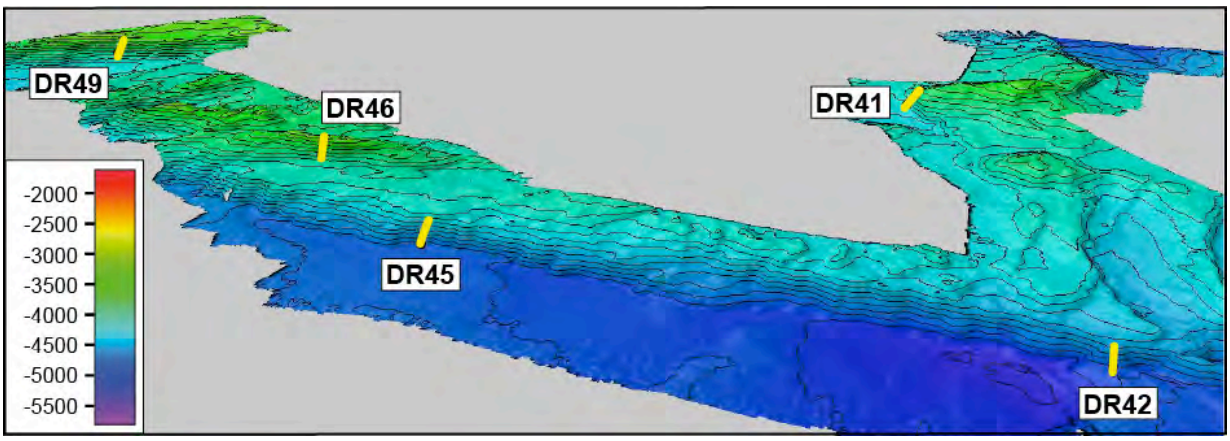


Dredge track DR38 at a seamount belonging to the newly discovered seamount chain extending from the "Southern Seamounts" to the north (view from WSW to ENE).

(D) Dredge Sites at the Afanasy Nikitin Complex

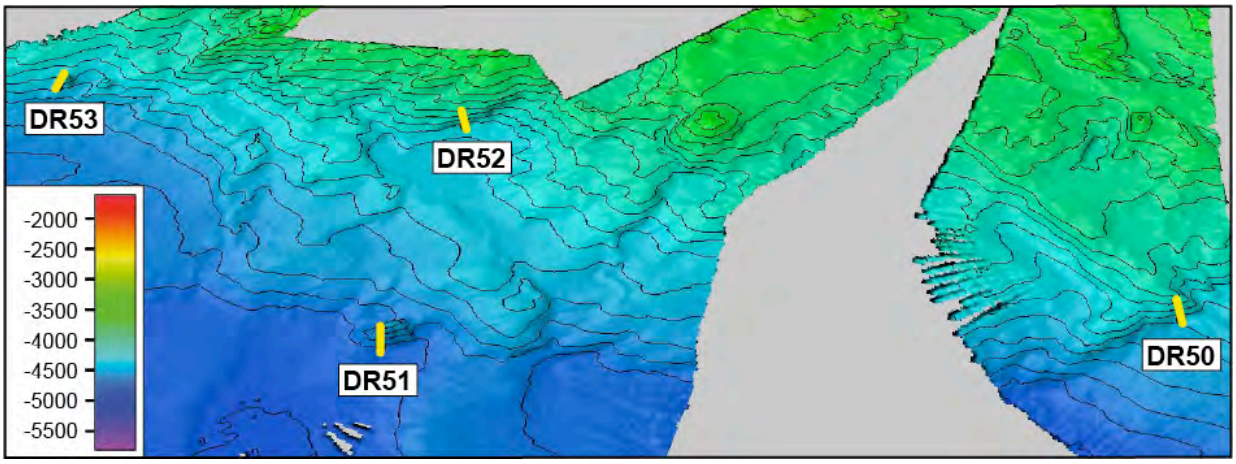


DR39 and 40 at east-west trending faults in the southernmost portion of the Afanasy Nikitin Complex (view from WSW to ENE).

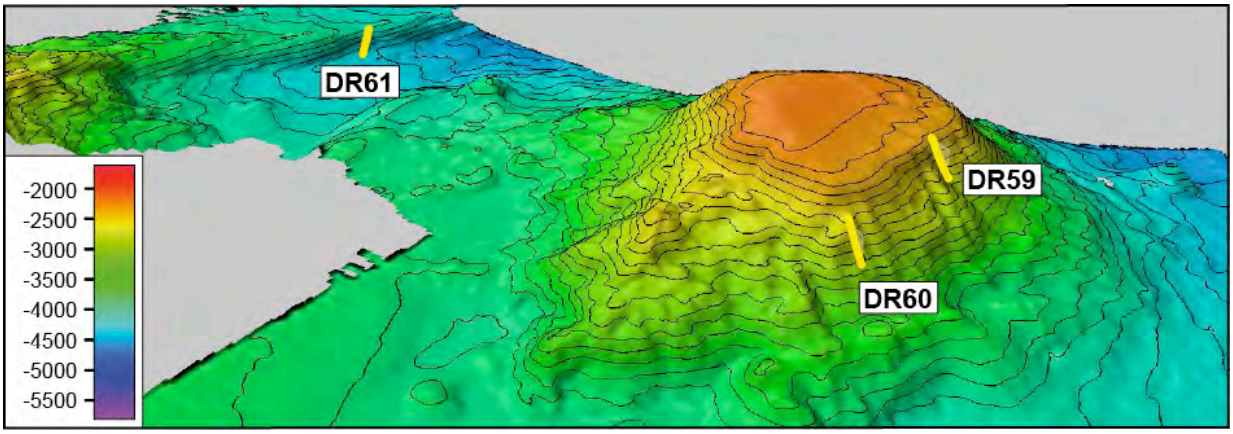


DR41 at a seamount on the southern Afanasy Nikitin platform and DR42, 45, 46, and 49 at its western margin (view from WSW to ENE).

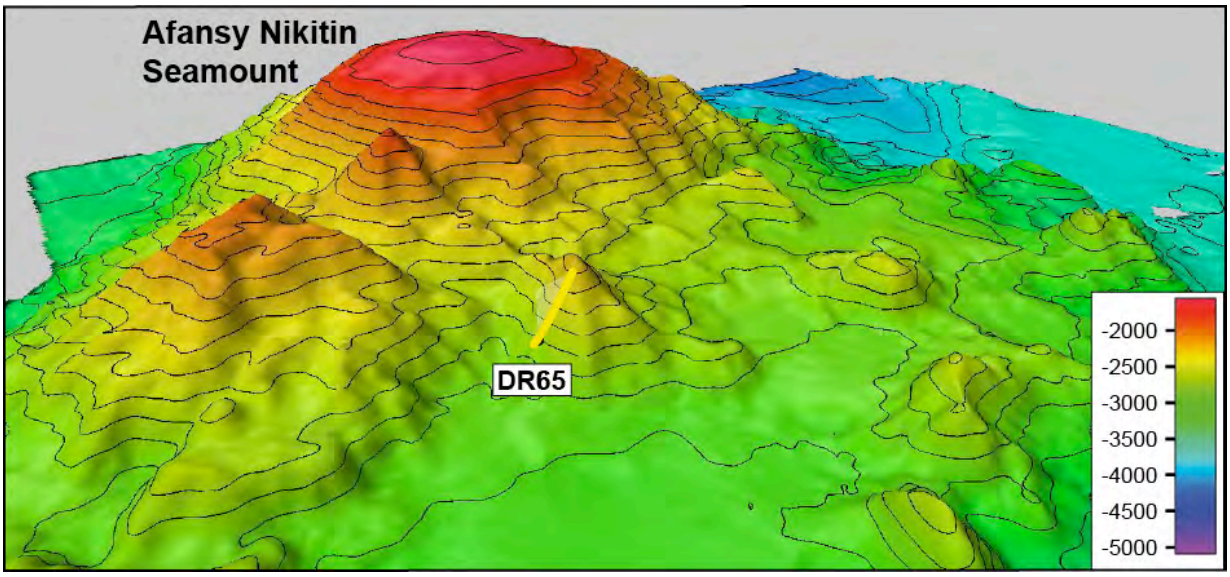
Appendix III (3D Maps of SO258 Leg 1 Dredge Tracks)



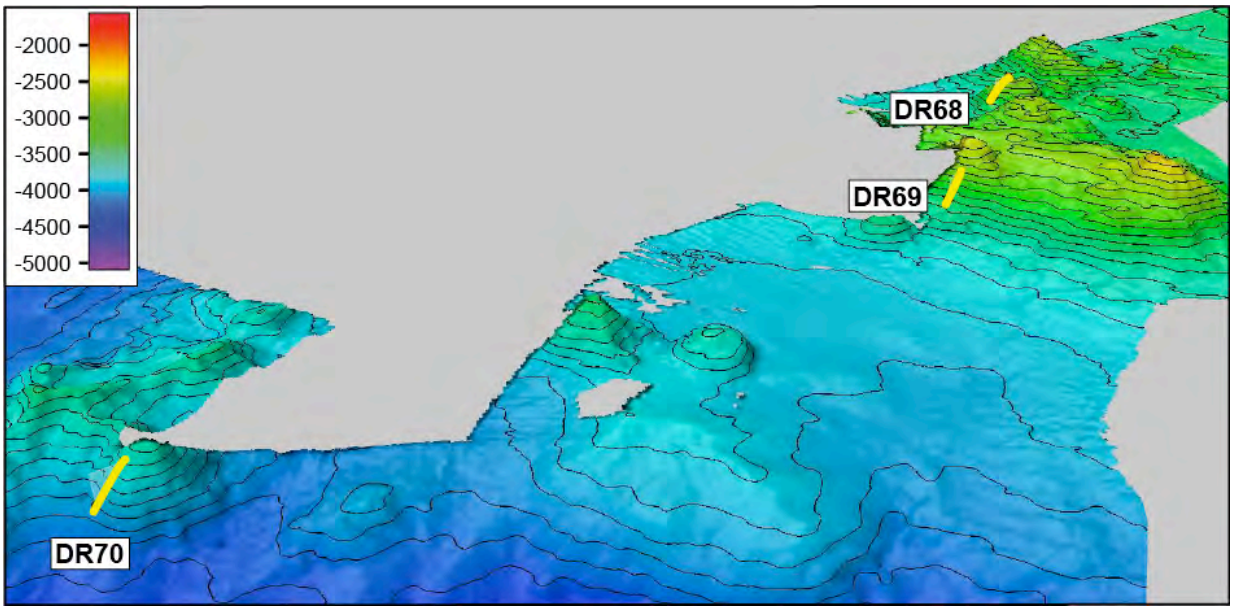
Dredge tracks DR50 - 53 at the central part of the western margin of the Afanasy Nikitin Complex (view from WSW to ENE).



DR60 and 61 at the upper slope of seamount C (according to Krishna et al. 2014) on the eastern flank of the Afanasy Nikitin Complex (view from SW to NE).

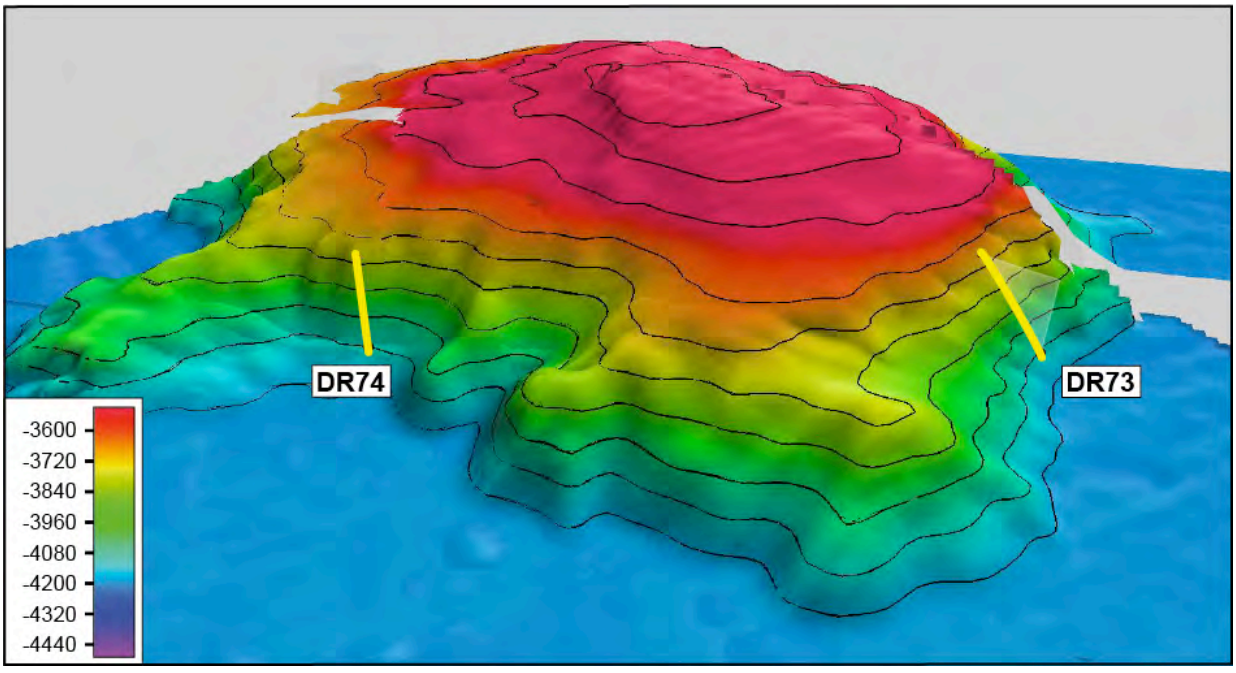


DR65 at a small satellite cone at the western footwall of Afanasy Nikitin Seamount (view from W to E).



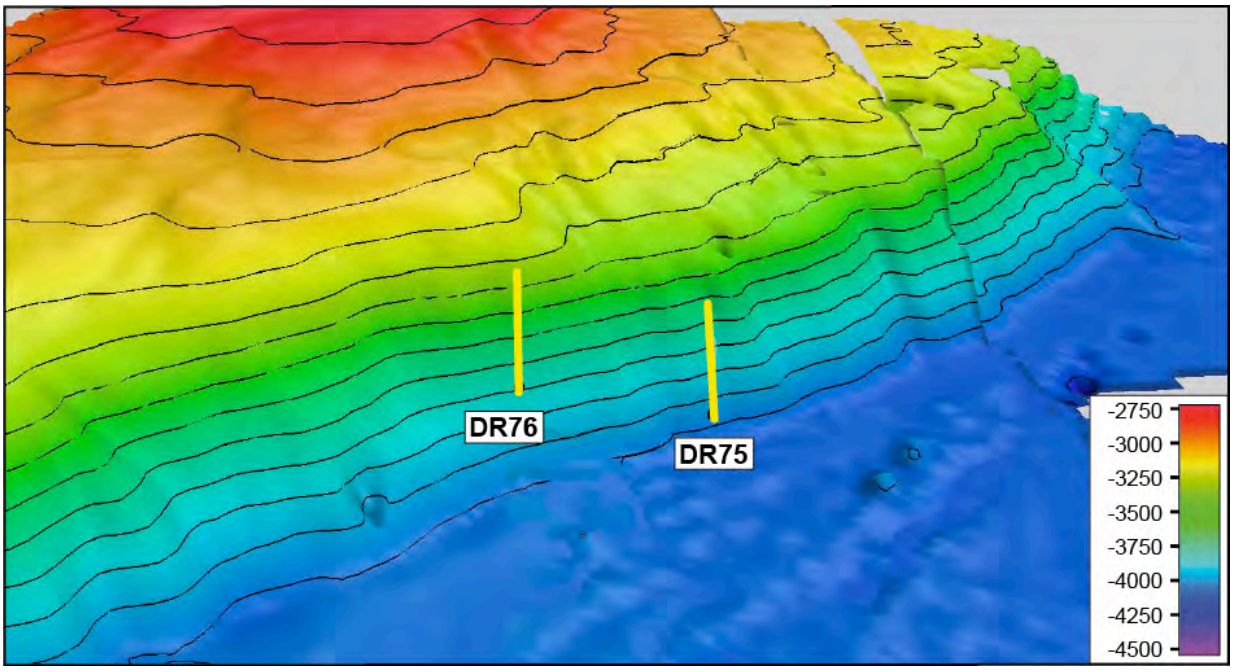
Dredge track DR68 - 70 in the northernmost section of the Afanasy Nikitin Complex (view from W to E).

(E) Dredge Sites at the Buried Hills

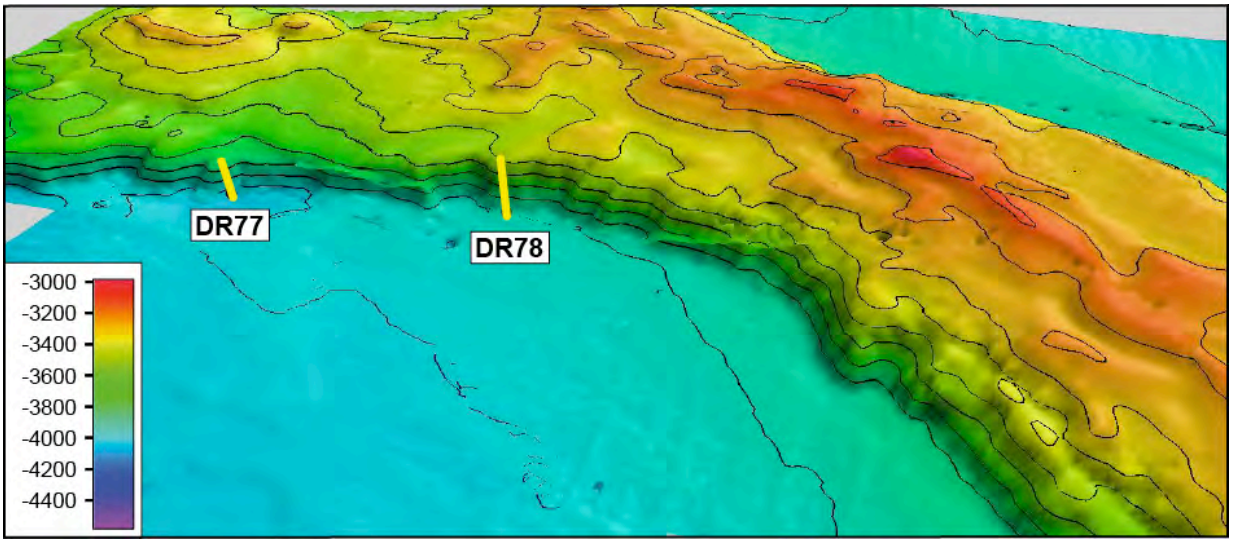


DR73 and 74 at a flat-topped seamount in the southern part of the Buried Hills (view from E to W).

Appendix III (3D Maps of SO258 Leg 1 Dredge Tracks)

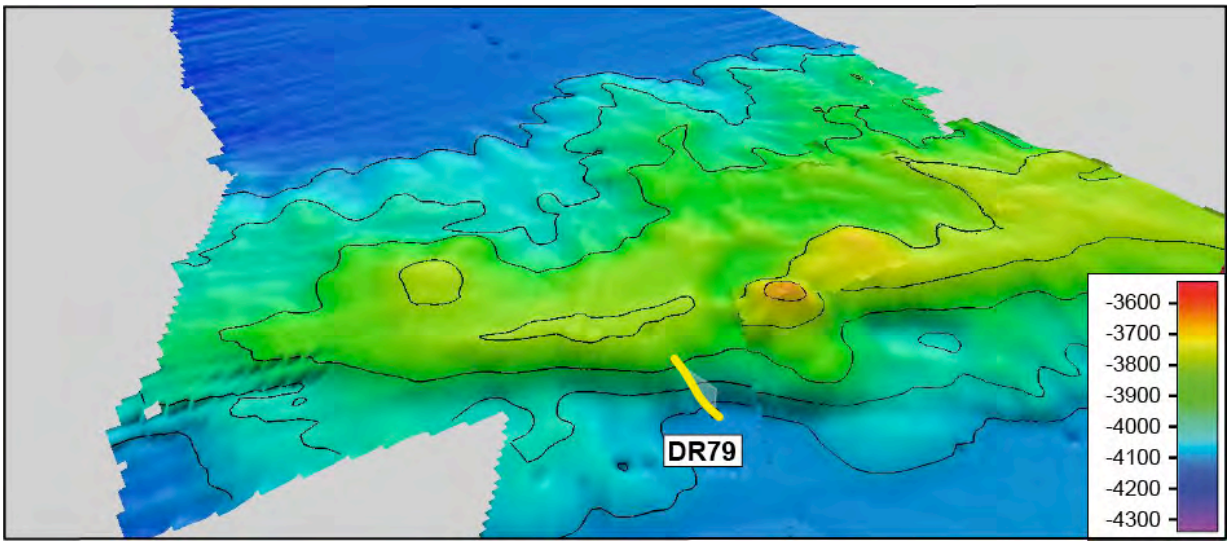


Dredge tracks DR77 and 78 at the western flank of a NNE-SSW-striking ridge representing the largest volcanic feature of the Buried Hills (view from N to S).



DR77 and 78 at the eastern flank of the NNE-SSW-striking ridge (view from ENE to WSW).

Appendix III (3D Maps of SO258 Leg 1 Dredge Tracks)



DR79 at the eastern flank of a less pronounced bathymetric high east of the NNE-SSW striking ridge (view from SE to NW).

Appendix IV (Tucker Trawl Deployment Data)

Trawl / Mission No.	Collection Type	Codend Type	Collection Depth (m)	Start Date (dd/mm/yy)	Start Lat	Start Lon	Time in	Time out	Ship speed (kn)
1	Neuston net	bucket	surface	09.06.17					1.5kn
2	RMT 25	bucket	ca. 1000m	09.06.17	27.1,063S	108.4,659E	14.10ish	17.00ish	1.5kn
3	Neuston net	bucket	surface	09.06.17					1.5kn
4	RMT 25	bucket	700, 650, 600, 550, 500m 30 min each	10.06.17	25.6,819S	106.11,639E	8.40ish	12.25ish	1.5kn
5	RMT 25	bucket	700, 650, 600, 550, 500m etc 30 mins	10.06.17	25.2,532S	106.9,318E	13.00ish	19.30ish	1.5kn
6	Neuston net	bucket	surface						1.5kn
7	RMT 25	bucket	1200, 1000, 800, 600, 400, 200, up	12.06.17	22.16,25S	102.26,132E	21.30ish	5.00ish	1.5kn
8	RMT 25	bucket	500, 300 then up	12.06.17	22.16,83S	102.26,70E	4.48ish	19.00 ish	1.5kn
9	RMT 25	bucket	1000, 8000, 600, 400, to surface	13.06.17	22.14,937	102.25,217E	12.00ish	6.30ish	1.5kn
10	RMT 25	bucket	400, 300, 200	14.06.17	22.15,066	102.26,004E	15.40ish	20.00ish	1.5kn
11	RMT 25	bucket	1000, 800, 200	14.06.17	22.15,021	102.27,885E	10.00ish	6.30ish	1.5kn
12	RMT 25	bucket	1100-1200, 200, 100	16.06.17	17.37,664	91.43,830E	14.40ish (r	20.00ish	1.5kn
13	RMT 25	bucket	800, 200, 100	17.06.17	17.41,723	91.53,663E	20.40ish	6.30ish	1.5kn
14	RMT 25	bucket	400, 200	17.06.17	17.3,321S	90.11,985E	16.10ish	19.00ish	1.5kn
15	RMT 25	bucket	1200, 800	18.06.17	17.4,910S	90.14,813E	19.30ish	6.30ish	1.5kn
16	RMT 25	bucket	400, 200	19.06.17	15.25,627	86,26,392E	16.00ish	19.00ish	1.5kn
17	RMT 25	bucket	200,	20.06.17	15.27,034	86.29,738E	19.45ish	12.00ish	1.5kn
18	RMT 25	bucket	400, 250	26.06.17	5.1,134S	82.17,844E	16.15ish	19.00ish	1.5kn
19	RMT 25	bucket	400, 250, 150	26.06.17	5.5.805S	82.21.498E	19.35ish	23.30ish	1.5kn
20	Neuston net	bucket	surface						1.5kn
21	RMT 25	bucket	400, 250	27.06.17	4.8,425S	82.34,118E	16.30ish	19.00ish	1.5kn
22	Neuston net	bucket	surface						1.5kn
23	Neuston net	bucket	surface						1.5kn
24	RMT 25	bucket	400, 250	28.06.17	4.10.799S	82.32,752E	19.00ish	23.30ish	1.5kn
25	RMT 25	bucket	1200, 800, 150	30.06.17	3.9,812S	82.26,288E	22.40ish	5.30ish	1.5kn
26	RMT 25	bucket	700, 150	30.06.17	3.14,420S	83.11,853E	16.15ish	19.30ish	1.5kn
27	RMT 25	bucket	800, 150	30.06.17	3.22,078S	83.14,561E	20.00ish	0.00ish	1.5kn
28	RMT 25	bucket	1000, 300	02.06.17	2,57,870S	83.3,683E	22.00ish	0.00ish	1.5kn
29	RMT 25	bucket	1200,	02.06.17	2.59,958S	83.2,964E	16.00ish	20.30ish	1.5kn
30	RMT 25	bucket	200,	02.06.17	3.6,697S	83.6,094E	20.40ish	23.30ish	1.5kn
31	RMT 25	bucket	800, 200	04.06.17	1.13,141N	85.23,051E	16.00ish	19.30ish	1.5kn

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
B201	3		mixed fish larvae						4% PFA	FC FdB
neuston										
		S201	Bristlemouth	Stomiiformes	Gonostomatidae	Cyclothone	acclidens		4% PFA	SC
		S202	Bristlemouth	Stomiiformes	Gonostomatidae	Cyclothone				DW
		S203	Bristlemouth	Stomiiformes	Gonostomatidae	Cyclothone	sp1		RNALater	DW
		S204	Bristlemouth	Stomiiformes	Gonostomatidae	Cyclothone	sp2		RNALater	FdB
		S205	Bristlemouth	Stomiiformes	Gonostomatidae	Cyclothone	sp1		100% Eth	FdB
		S206	Bristlemouth	Stomiiformes	Gonostomatidae	Cyclothone	sp2		100% Eth	FdB
		S207	Bristlemouth	Stomiiformes	Gonostomatidae	Cyclothone	acclidens		4% PFA	TL
B202	4		Bristlemouth	Stomiiformes	Gonostomatidae	Cyclothone	sp1		RNALater	FdB
B203	4		Bristlemouth	Stomiiformes	Gonostomatidae	Cyclothone	sp2		RNALater	FdB
neuston										
		S208	Barreleye	Argentiniformes	Opisthoproctidae	Opisthoproctus				JP
		S209	Barreleye	Argentiniformes	Opisthoproctidae	Opisthoproctus			Formalin	HJW
		S210	Hatchetfish	Stomiiformes	Sternoptychidae	Argyropelecus				HJW
		S211	Lanternfish	Myctophiformes	Myctophidae	Diaphus		70,7	Formalin	FdB
B204	4		Hatchetfish	Stomiiformes	Sternoptychidae	Argyropeleus				JP
B205	8		Hatchetfish	Stomiiformes	Sternoptychidae	Argyropeleus			4% PFA, glut, RNALater	FdB
B206	3		squid							W-S C
		S212	Viperfish	Stomiiformes	Stomiidae	Chauliodus	Sloani			TL
		S213								DW
		S2014	Lanternfish	Myctophiformes	Myctophidae	Diaphus		37,7	Formalin	FdB
B207	7		Hatchetfish	Stomiiformes	Sternoptychidae	Argyropeleus	hemigymnus			LC
B208	2		Viperfish	Stomiiformes	Stomiidae	Chauliodus	Sloani		4% PFA + RNALAter	FdB
B209	4		Hatchetfish	Stomiiformes	Sternoptychidae	Argyropeleus			Glut + RNALater	FdB
		S215	Viperfish	Stomiiformes	Stomiidae	Chauliodus	Sloani			TL

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
		S216	Viperfish	Stomiiformes	Stomiidae	Chauliodus	Sloani			TL
		S217	Viperfish	Stomiiformes	Stomiidae	Chauliodus	Sloani			LC
		S218								FC
		S219	Viperfish	Stomiiformes	Stomiidae	Chauliodus	Sloani		RNALater	FC FdB
		S220	Lanternfish	Myctophiformes	Myctophidae				RNALater	FC FdB
B210	2		Bristlemouth	Stomiiformes	Gonostomatidae	Cyclothone	microdon? Or acclidens			LC SP
B211	5		Lanternfish	Myctophiformes	Myctophidae	Notolychnus ?	valvidiae		Glut + RNALater	FC FdB
B212	5		Bristlemouth	Stomiiformes	Gonostomatidae	Cyclothone			Glut + RNALater	FC FdB
		S221	eel						RNALater	FC
		S222	Bristlemouth	Stomiiformes	Gonostomatidae	Gonostoma	elongatum	143	4% PFA	LC
		S223	Lanternfish	Myctophiformes	Myctophidae	Lampanyctus	alatus	49	4% PFA	LC
		S224	Lanternfish	Myctophiformes	Myctophidae	Lampanyctus	alatus	47	4% PFA	LC
		S225	Viperfish	Stomiiformes	Stomiidae	Chauliodus	Sloani			UM
		S226	Barreleye	Argentiniformes	Opisthoproctidae	Opisthoproctus		84,4		FdB FC
		S227	Barreleye	Argentiniformes	Opisthoproctidae	Opisthoproctus				HJW
		S228	Hatchetfish	Stomiiformes	Sternoptychidae	Sternoptix				HJW
		S229	Viperfish	Stomiiformes	Stomiidae	Chauliodus	Sloani			HJW
		S230	Bristlemouth	Stomiiformes	Gonostomatidae	Gonostoma	sp			HJW
		S231	Bristlemouth	Stomiiformes	Gonostomatidae	Gonostoma	elongatum			TL
B213	12		Hatchetfish	Stomiiformes	Sternoptychidae	Argyropeleus	hemigymnus			
B214	10		Lanternfish	Myctophiformes	Myctophidae					
B215										
B216	5		(4 squid, 1 octopus)							WS
B217	2		Viperfish	Stomiiformes	Stomiidae	Chauliodus	Sloani			TL
B218	4		Hatchetfish	Stomiiformes	Sternoptychidae	Sternoptix			RNALater + glut	FdB
		S232	Viperfish	Stomiiformes	Stomiidae	Chauliodus	Sloani			TL
		S233	Viperfish	Stomiiformes	Stomiidae	Chauliodus	Sloani			TL

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
		S234	Hatchetfish	Stomiiformes	Sternoptychidae	Argyropeleus		62,6		FC FdB
		S235	Hatchetfish	Stomiiformes	Sternoptychidae	Argyropeleus	affinis	60,2		FC FdB
		S236	Barbeled dragonfishes	Stomiiformes	Stomiidae	Photostomias		94,4	formalin	FC FdB
		S237	Lightfish	Stomiiformes	Phosichthyidae	Phoscichthys	argenteus	156,3	formalin	FC FdB
B219	3		Hatchetfish	Stomiiformes	Sternoptychidae				RNALater + 4% PFA	FC FdB
		S238	Elongate fangjaw	Stomiiformes	Gonostomatidae	Gonostoma		141,4		FC FdB
		S239	Elongate fangjaw	Stomiiformes	Gonostomatidae	Gonostoma		150		FC FdB
		S240	Elongate fangjaw	Stomiiformes	Gonostomatidae	Gonostoma			formalin	FC FdB
		S241	Elongate fangjaw	Stomiiformes	Gonostomatidae	Gonostoma		134		FC FdB
		S242	Elongate fangjaw	Stomiiformes	Gonostomatidae	Gonostoma				FC FdB
		S243	anglerfish	Lophiiformes					RNALater	FC FdB
		S244	Ridgehead	Stephanoberyciformes	Melamphaidae	Melamphaes ?		23,6	RNALater	FC FdB
B220	lots		mixed fish						formalin	Aus museum
B221	7		Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani			
		B221-1	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani	140		FC FdB
		B221-2	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani	99		FC FdB
		B221-3	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani	84		FC FdB
B221-4	3		Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani		RNALater	FC FdB
B221-5	1		Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani		glut	FC FdB
		S245	Ridgehead	Stephanoberyciformes	Melamphaidae	Melamphaes ?			RNALater	FC FdB
B222-1	3		Lanternfish	Myctophiformes	Myctophidae	Lampanyctus	alatus		RNALater	FC FdB
B222-2	2		Lanternfish	Myctophiformes	Myctophidae	Lampanyctus	alatus		4% PFA	FC FdB
B222-3	2		Lanternfish	Myctophiformes	Myctophidae	Lampanyctus	alatus		glut	FC FdB
B223-1	2		Lanternfish	Myctophiformes	Myctophidae	Bolinichthys	phototorax		RNALater	FC FdB
		B223-2	Lanternfish	Myctophiformes	Myctophidae	Bolinichthys	phototorax		4% PFA	FC FdB
		B222-3	Lanternfish	Myctophiformes	Myctophidae	Bolinichthys	phototorax		glut	FC FdB
		S246	Lanternfish	Myctophiformes	Myctophidae	Diaphus			formalin	FC FdB
B224	4		Lanternfish	Myctophiformes	Myctophidae	Diaphus	4 different sp		4% PFA	FC FdB

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
	1	B224-1	Lanternfish	Myctophiformes	Myctophidae	Diaphus	luetkeni		4% PFA	FC FdB
	1	B224-2	Lanternfish	Myctophiformes	Myctophidae	Diaphus	parri (female)		4% PFA	FC FdB
		S247	Codlet	Gadiformes	Bregmacerotidae	Bregmaceros			RNALater	FC FdB
		S248	eel						RNALater	FC FdB
		S249	eel larvae						RNALater	FC FdB
		S250	eel larvae					195	RNALater	
B225	2		Lanternfish	Myctophiformes	Myctophidae	Centrobranchus	nigrocellatus		RNALater	FC FdB
		S251	Lanternfish	Myctophiformes	Myctophidae	Centrobranchus	nigrocellatus	24,5	glut	FdB
		S252	Hatchetfish	Stomiiformes	Sternoptychidae	Sternoptix				HJW
		S253	Hatchetfish	Stomiiformes	Sternoptychidae	Sternoptix				HJW
		S253	Hatchetfish	Stomiiformes	Sternoptychidae	Argyropeleus				HJW
		S255	Ridgehead	Stephanoberyciformes	Melamphaidae	Poromitra	crassiceps	75,7	4% PFA	LC
		S256	Basslet	Perciformes	Howellidae	Howella	sherboni	67,35		LC
		S257	Boa dragonfish	Stomiiformes	Stomiidae	Stomias	boa	207		FC FdB
		S258	Whalefish	Cetomimiformes	Cetomimidae				Glut	JM
		S259	Barreleye	Argentiniformes	Opisthoproctidae	Opisthoproctus		83		FC FdB
		S260	Ridgehead	Stephanoberyciformes	Melamphaidae			74,8	formalin	FC FdB
		S261	Lanternfish	Myctophiformes	Myctophidae	Diaphus		70	formalin	FC FdB
		S262	Anglerfish	Lophiiformes				33	RNALater	FC FdB
		S263	Ridgehead	Stephanoberyciformes	Melamphaidae				RNALater	FC FdB
		S264	Dragonfish	Stomiiformes	Stomiidae	Melanostomias ?	niger ?	80	RNALater	FC FdB
		S265	Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani			TL
		S266	Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani			TL
		S267	Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani			TL
		S268	Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani			TL

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
		S269	Viperfish	Stomiiformes	Stomiidae	Chauliodus	Sloani			TL
		S270	Telescopefish	Aulopiformes	Giganturidae	Gigantura	chuni			HJW
		S271	Lanternfish	Myctophiformes	Myctophidae	Nanobrachium	cf. nigrum			TL
		S272	Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani			TL
B226										
B227	6		Hatchetfish	Stomiiformes	Sternoptychidae	Sternoptyx	diaphana			TL
B228	5		Hatchetfish	Stomiiformes	Sternoptychidae				3 heads in RNALater, 1 in formalin, 1 in 100% Eth	JP FC
B229	6		Ridgehead	Stephanoberyciformes	Melamphaidae				formalin, RNALater, 4% PFA, Glut	FC FdB
B230	6		Ridgehead	Stephanoberyciformes	Melamphaidae				formalin, RNALater, 4% PFA, Glut	FC FdB
B231	4		Black dragonfish	Stomiiformes	Stomiidae	Idiacanthus			RNALater, 4% PFA, glut	FC FdB
		S264	Dragonfish	Stomiiformes	Stomiidae				RNALater	FC FdB
B232	11		Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani		formalin, RNALater, 4% PFA, Glut	FC FdB
B233	5		Lanternfish	Myctophiformes	Myctophidae	Nannobrachium	cf nigrum		formalin, RNALater, 4% PFA, Glut	FC FdB
		S273	Ridgehead	Stephanoberyciformes	Melamphaidae	Poromitra	crassiceps	120	4% PFA	LC
		S274	Lanternfish	Myctophiformes	Myctophidae	Diaphus		56,5	formalin	FC FdB
		S275	Lanternfish	Myctophiformes	Myctophidae	Diaphus		64,3	formalin	FC FdB
		S276	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani	154,8	formalin	FC FdB
		S277	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani	88	100% Eth	FC FdB
B234	6		Hatchetfish	Stomiiformes	Sternoptychidae	Sternoptix			4% PFA, glut	FC FdB
		S278	Snaketooth fish	Perciformes	Chiasmodontidae	Chiasmodon		55	formalin	FC FdB
		S279	Snaketooth fish	Perciformes	Chiasmodontidae	Chiasmodon		33	RNALater	FC FdB
		S280	Snaketooth fish	Perciformes	Chiasmodontidae	Chiasmodon		30,8	RNALater	FC FdB
B235	5		Bristlemouth	Stomiiformes	Gonostomatidae	Cyclothone			RNALater, 4% PFA, glut	FC FdB

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
B236	4		Ridgehead	Stephanoberyciformes	Melamphaidae				Formalin, 4% PFA, RNALater	FC FdB
		S281		Stomiiformes	Gonostoma or Diplophos?			72,8		FC FdB
		S282		Stomiiformes				50	RNALater	FC FdB
		S283	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani	195		FC FdB
B237	lots		Mixed fish and crustaceans						formalin	
		S284	Ask Fab							
		S285	Hatchetfish	Stomiiformes	Sternoptychidae	Argyropeleus	affinis			HJW
		S286	Lightfish	Stomiiformes	Phosichthyidae	Ichthyococcus		39	glut	FC FdB
		S287	Eel Larvae							SC
B238	2		Hatchetfish	Stomiiformes	Sternoptychidae					DW
		S288	Pearleye	Aulopiformes	Scopelarchidae	Scopelarchus		34	RNALater	FC FdB
		S289	VOID							
		S290	Lanternfish	Myctophiformes	Myctophidae	Diaphus		63,4	formalin	FC FdB
B239	20		Bristlemouth	Stomiiformes	Gonostomatidae	Cyclothone				DW
		S291	Telescopefish	Aulopiformes	Giganturidae	Gigantura	Indica			HJW
		S292	Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani			SP
		S293	Omosudid	Aulopiformes	Omosudidae	Omosudis	lowii			SP
		S294	Omosudid	Aulopiformes	Omosudidae	Omosudis	lowii			SP
		S295	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani			SP
		S296	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani			SP
		S297	Dragonfish	Stomiiformes	Stomiidae	Stomias	affinis			SP
		S298	Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani			SP
		S299	barbeled dragonfishes	Stomiiformes	Stomiidae	Eustomias ?			RNALater	SP, FC FdB
B240	15		Hatchetfish	Stomiiformes	Sternoptychidae					DW
B241	9		Lanternfish	Myctophiformes	Myctophidae					DW
		S300	Hatchetfish	Stomiiformes	Sternoptychidae	Sternoptix		60	formalin	
	baby	S301	anglerfish	Lophiiformes						

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
		S302	Snaketooth fish	Perciformes	Chiasmodontidae	Pseudoscopelus	altipinnis?	295	formalin	FC FdB
		S303	Lanternfish	Myctophiformes	Myctophidae	Diaphus	phillipsi	105,8	formalin	FC FdB
		S304	whalefish	Cetomimiformes				91,4	glut	JM
		S305	Bristlemouth	Stomiiformes	Gonostomatidae	Gonostoma	bathyphilum	81	RNALater	Wayne Davis
		S306	Basslet	Perciformes	Howellidae	Howella	sp	83,4	formalin	FC FdB
B242	4 juveniles		Hatchetfish	Stomiiformes	Sternoptychidae	Sternoptix			RNALater	FC
B243	5		Ridgehead	Stephanoberyciformes	Melamphaidae				RNALater, 4% PFA, glut, formalin	FC FdB
		S307	Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani			TL
		S308	Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani			TL
		S309	Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani			TL
		S310	Swallower?	Perciformes	Chiasmodontidae	Chiasmodon?		54	4% PFA	FC FdB
		S311	Snaggletooths	Stomiiformes	Stomiidae	Astronesthes	sp	26,3	RNALater	FC FdB
		S312	Snaggletooths	Stomiiformes	Stomiidae	Astronesthes	sp	34	4% PFA	FC FdB
B245	5		Lanternfish	Myctophiformes	Myctophidae	Nannobrachium	cf nigrum		RNALater, 4% PFA, glut, formalin	FC FdB
		S313	Lanternfish	Myctophiformes	Myctophidae	Lampanyctus		39,4	RNALater	FC FdB
B246	6		Lanternfish	Myctophiformes	Myctophidae	Diaphus	brachycephalus		RNALater, 4% PFA, glut	FC FdB
B247	2		Lanternfish	Myctophiformes	Myctophidae	Benthosema	suborbitale		RNALater, 4% PFA	FC FdB
B248	3		Lanternfish	Myctophiformes	Myctophidae	Diaphus ?	diadematus ?		4% PFA	FC FdB
		S314	Lanternfish	Myctophiformes	Myctophidae	Myctophum	nitidulum	32,5	4% PFA	FC FdB
		S315	Lanternfish	Myctophiformes	Myctophidae	Lobianchia	gemellari	59	4% PFA	FC FdB
		S316	Lanternfish	Myctophiformes	Myctophidae	Diaphus	lucidus	53,9	4% PFA	FC FdB
		S317	Lanternfish	Myctophiformes	Myctophidae	Diaphus	mollis	38,4	4% PFA	FC FdB
		S318	Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani	600	formalin	FC FdB
		S319	Ridgehead	Stephanoberyciformes	Melamphaidae			36	RNALater	FC FdB
		S320	Ridgehead	Stephanoberyciformes	Melamphaidae			22	RNALater	FC FdB
B249			Mixed fish						formalin	

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
		S321	Bristlemouth	Stomiiformes	Gonostomatidae	Gonostoma	elongatum	139		LC
		S322	Bristlemouth	Stomiiformes	Gonostomatidae	Gonostoma	elongatum			LC
		S323	Bristlemouth	Stomiiformes	Gonostomatidae	Gonostoma	elongatum	130		LC
		S324	Bristlemouth	Stomiiformes	Gonostomatidae	Gonostoma	elongatum	135		LC
B250	6		Lanternfish	Myctophiformes	Myctophidae					DW
B251	4		Hatchetfish	Stomiiformes	Sternoptychidae					DW
		S325	Lanternfish	Myctophiformes	Myctophidae	Diaphus		62	formalin	FC FdB
		S326	Lanternfish	Myctophiformes	Myctophidae	Diaphus		55,7	formalin	FC FdB
		S327	Lanternfish	Myctophiformes	Myctophidae	Diaphus		45,9	formalin	FC FdB
		S328	Lanternfish	Myctophiformes	Myctophidae	Bolinicthys		42	formalin	FC FdB
B252	2		Lanternfish	Myctophiformes	Myctophidae	Bolinicthys		15.7, 21	RNALater, glut	FC FdB
B253	3		Lanternfish	Myctophiformes	Myctophidae	Nannobrachium			RNALater, 4% PFA, glut	FC FdB
B254	2		Hatchetfish	Stomiiformes	Sternoptychidae	Sternoptix			RNALater, 4% PFA in-situ	FC FdB
B255	2		Hatchetfish	Stomiiformes	Sternoptychidae	Argyropelecus			RNALater, 4% PFA in-situ	
		S329	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani			TL
		S330	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani			TL
		S331	Bristlemouth	Stomiiformes	Gonostomatidae	Gonostoma	elongatum			TL
B256			Cephalopods							WS
		S332	Lanternfish	Myctophiformes	Myctophidae			25,6	RNALater	FC FdB
		S333	anglerfish	Lophiiformes						FC FdB
		S334	Bristlemouth	Stomiiformes	Gonostomatidae	Gonostoma	elongatum			LC
		S333	Bristlemouth	Stomiiformes	Gonostomatidae	Gonostoma				HJW
B257	12		Lanternfish	Myctophiformes	Myctophidae					DW
B258	15		Hatchetfish	Stomiiformes	Sternoptychidae					DW
B259	9		Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani		RNALater, 100% Eth, formalin	FC, Stuart
B260	13		Hatchetfish	Stomiiformes	Sternoptychidae	Sternoptix			100% Eth, formalin	Stuart

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
		S335								
		S336	Telescopefish	Aulopiformes	Giganturidae	Gigantura	indica			HJW
		S337								
		S338	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani			SP
		S339	Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani			SP
		S340	Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani			SP
		S341	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani			SP
		S342	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani			SP
		S343	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani			SP
		S344	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani			SP
		S345	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani			SP
		S346	Bristlemouth	Stomiiformes	Gonostomatidae	Gonostoma	elongatum			SP
		S347	Hatchetfish	Stomiiformes	Sternoptychidae	Sternoptix		52,9		FC FdB
		S348	Hatchetfish	Stomiiformes	Sternoptychidae	Sternoptix		41,4		FC FdB
		S349	anglerfish	Lophiiformes					RNALater	FC FdB
		S350	anglerfish	Lophiiformes					100% Eth	FC FdB
		S351	Ridgehead	Stephanoberyciformes	Melamphaidae			122		FC FdB
		S352								
B261	15		Hatchetfish babies	Stomiiformes	Sternoptychidae	Sternoptix			RNALater, 4% PFA, glut	FC FdB
B262	2		Hatchetfish babies	Stomiiformes	Sternoptychidae	Argyropelecus			RNALater	FC FdB
B263			Cephalopods							WS
B264	3		Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani		RNALater (head only)	FC FdB
B265	7		Lanternfish	Myctophiformes	Myctophidae	Lampanyctus	alatus		RNALater, 4% PFA, glut, formalin	FC FdB
B266	5		Lanternfish	Myctophiformes	Myctophidae	Bolinicthys			RNALater, 4% PFA	FC FdB
B267	2		Lanternfish	Myctophiformes	Myctophidae	Diaphus	brachycephalus		4% PFA, glut	FC FdB
B268	3		Lanternfish	Myctophiformes	Myctophidae	2x Diaphus, 1x Nannobrachium			formalin	FC FdB

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
B269	9		Bristlemouth	Stomiiformes	Phosichthyidae	Vinciguerria			RNALater, 4% PFA, glut	FC FdB
		S353	Loosejaw	Stomiiformes	Stomiidae	Malacosteus ?		62	formalin	FC FdB
		S354	Hatchetfish	Stomiiformes	Sternoptychidae	Sternoptix		39	100% Eth	Stuart
B270	2		Ridgehead	Stephanoberyciformes	Melamphaidae			53, 72	heads in 4% PFA, RNALater	FC FdB
		S355	barbeled dragonfishes	Stomiiformes	Stomiidae	Eustomias		116,5	formalin	FC FdB
		S356	?	Stomiiformes	?	?			formalin	FC FdB
		S357	barbeled dragonfishes	Stomiiformes	Stomiidae	Eustomias		110	formalin	FC FdB
		S358	Black dragonfish	Stomiiformes	Stomiidae	Idiacanthus		242	formalin	FC FdB
		S359	Black dragonfish	Stomiiformes	Stomiidae	Idiacanthus			RNALater	FC FdB
		S360	Black dragonfish	Stomiiformes	Stomiidae	Idiacanthus		140	glut	FC FdB
B271	4		Mixed fish, 1 viperfish, 3 melamphase						formalin	FC FdB
		S361	Gulper eel	Saccopharyngiformes	Eurypharyngidae	Eurypharynx	pelecanoides		glut	JM
		S362		Stomiiformes					formalin	FC FdB
		S363	earlier trawl anglerfish (film crew)							
		S364	Bristlemouth	Stomiiformes	Gonostomatidae	Gonostoma				HJW
		S365	Telescopefish	Aulopiformes	Giganturidae	Gigantura	Indica			HJW
B272	12		Bristlemouth	Stomiiformes	Gonostomatidae	Cyclothone				DW
		S366	Whalefish	Cetomimiformes	Cetomimidae	Cetominus ?		68	glut	JM
		S367	Whalefish	Cetomimiformes	Cetomimidae	Cetominus ?		79,8	glut	JM
		S368	Swallower	Perciformes	Chiasmodontidae	Chiasmodon		124	formalin	FC FdB
		S369	Swallower	Perciformes	Chiasmodontidae	Chiasmodon		82,4	formalin	FC FdB
		S370	Hatchetfish	Stomiiformes	Sternoptychidae	Sternoptix		39,3	100% Eth	FC FdB
		S371	anglerfish	Lophiiformes	Linophrynidae	Linophryne			glut	FC FdB
		S372	anglerfish	Lophiiformes	Melanocetidae	Melanocetus	johnsonii		RNALater	FC FdB
B273	4		Hatchetfish	Stomiiformes	Sternoptychidae	Sternoptix			100% Eth	Stuart
B274	2		Black dragonfish	Stomiiformes	Stomiidae	Idiacanthus			RNALater	FC FdB
		S373	Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani			SC

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
		S374	Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani			SC
		S375	Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani			SC
		S376	Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani			SC
		S377	Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani			SC
		S378	Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani			SC
		S379	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani			SC
		S380	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani			SC
		S381	Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani			SC
		S382	Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani			SC
		S383	Telescopefish	Aulopiformes	Giganturidae	Gigantura	indica			HJW
		S384	Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani			TL
		S385	Hatchetfish	Stomiiformes	Sternoptychidae	Sternoptix			formalin	JP, FC FdB
		S386	barbeled dragonfishes	Stomiiformes	Stomiidae	Eustomias		160	formalin	FC FdB
		S387	Barracudina	Aulopiformes	Paralelipidae ?			84,7		FC FdB
		S388				Melastomias ?		150	formalin	FC FdB
		S389	Telescopefish	Aulopiformes	Giganturidae	Gigantura	indica	70	glut	FC FdB
B275	2		Mixed dragonfish						RNALater	FC FdB
		S390	Eel	Anguilliformes	Nemichthyidae	Nemichthys			RNALater	FC FdB
		S391	Eel	Anguilliformes	Nemichthyidae	Nemichthys			RNALater	FC FdB
B276	10		Bristlemouth	Stomiiformes	Phosichthyidae	Vinciguerria			RNALater, 4% PFA, glut	FC FdB
		S392	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani	208	formalin	TL
		S393	Hatchetfish	Stomiiformes	Sternoptychidae	Sternoptix		43	4% PFA	FC FdB
		S394	Lanternfish	Myctophiformes	Myctophidae	Lampanyctus	alatus	50	glut	FC FdB
B277			Cephalopods							WS
B278	2		Lanternfish	Myctophiformes	Myctophidae	Lampanyctus + Nannobrachium	nobilis + cf nigrum		4% PFA	FC FdB
		S395	Lanternfish	Myctophiformes	Myctophidae	Diaphus	brachycephalus	37,2	in-situ	FC FdB
B279	3		Lanternfish	Myctophiformes	Myctophidae	Benthosema	suborbitale		RNALater, 4% PFA, glut	FC FdB

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
B280	4		Lanternfish	Myctophiformes	Myctophidae	Ceratoscopelus	warmingii		RNALater, 4% PFA, glut	FC FdB
		S396	Lanternfish	Myctophiformes	Myctophidae	Ceratoscopelus	warmingii	35,7	4% PFA	FC FdB
B281	5 babies		Lanternfish	Myctophiformes	Myctophidae				RNALater, glut	FC FdB
B282	3 mixed sp		Ridgehead	Stephanoberyciformes	Melamphaidae				100% Eth	FC FdB
B283	2		Eel larvae						RNALater	FC FdB
		S397	Hatchetfish	Stomiiformes	Sternoptychidae	Argyropeleus	affinis			HJW
		S398	Pearleye	Aulopiformes	Scopelarchidae	Scopelarchus	analis			HJW
		S399	Lanternfish	Myctophiformes	Myctophidae	Lampanyctus	alatus	97	4% PFA	LC
B284	13		Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani			SC
		S400	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani			SC
		S401	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani			SC
		S402	Telescopefish	Aulopiformes	Giganturidae	Gigantura	chuni			SC
		S403	Telescopefish	Aulopiformes	Giganturidae	Gigantura	chuni			SC
		S404	Lanternfish	Myctophiformes	Myctophidae	Lampanyctus	alatus			SC
		S405	Lanternfish	Myctophiformes	Myctophidae	Lampanyctus	alatus			SC
		S406		Aulopiformes	Paralepididae	Paralepis	brevirostris			SC
		S407		Aulopiformes	Paralepididae	Paralepis	brevirostris			SC
		S408		Aulopiformes	Paralepididae	Paralepis	brevirostris			SC
		S409		Aulopiformes	Paralepididae	Paralepis	brevirostris			SC
		S410		Aulopiformes	Paralepididae	Paralepis	brevirostris			SC
B285	14		Hatchetfish	Stomiiformes	Sternoptychidae	Sternoptix			100% Eth, RNALater	FC FdB
B286	9		Telescopefish	Aulopiformes	Giganturidae	Gigantura	indica		RNALater, 4% PFA, glut	FC FdB
B287	10		Bristlemouth	Stomiiformes	Gonostomatidae	Cyclothone			RNALater, 4% PFA, glut, 100% Eth	FC FdB
		S411	Lanternfish	Myctophiformes	Myctophidae	Bolinichthys	supralateralis ?	92,3	4% PFA	FC FdB
		S412	Hatchetfish	Stomiiformes	Sternoptychidae	Argyropeleus		54		FC FdB
		S413	anglerfish male	Lophiiformes					RNALater	FC FdB

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
		S414	anglerfish baby female	Lophiiformes					RNALater	FC FdB
		S415	Threadfin dragonfish	Stomiiformes	Stomiidae	Echiostoma ?	barbatum	170	formalin	FC FdB
		S416	Pearleye	Aulopiformes	Scopelarchidae	Scopelarchus	analis			HJW
B281	24		Hatchetfish	Stomiiformes	Sternoptychidae	Sternoptix				DW
B288										
B289	14		Hatchetfish	Stomiiformes	Sternoptychidae	Sternoptix				JP
B290	2		anglerfish	Lophiiformes	Melanocetidae	Melanocetus	johnsonii		RNALater, glut	JM
B291	2		anglerfish	Lophiiformes	Ceratiidae	Cryptopsaras	couesii		RNALater, glut	JM
		S417								
		S418	Crested bigscale	Stephanoberyciformes	Melamphaidae	Pomoitra	crassiceps			
		S419	larvae	Stomiiformes	Stomiidae	Idiacanthus			RNALater	FC FdB
		S420	anglerfish	Lophiiformes	Melanocetidae	Melanocetus	johnsonii		RNALater	FC FdB
		S421	eel					175	formalin	FC FdB
B292	2		?						RNALater, 4% PFA	FC FdB
B293	3		Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani			TL
		S422	Swallower	Perciformes	Chiasmodontidae	Chiasmodon		30,9	RNALater	FC FdB
B294	6		Lanternfish	Myctophiformes	Myctophidae	Nannobrachium			RNALater, formalin	FC FdB
		S423	Lanternfish	Myctophiformes	Myctophidae	Ceratoscopelus	warmingii	31,3	in-situ	FC FdB
		S424	Lanternfish	Myctophiformes	Myctophidae	Bolinichthys		29	in-situ	FC FdB
B295	2		Lanternfish	Myctophiformes	Myctophidae	Diaphus		27,3	RNALater, glut	FC FdB
		S425	Lanternfish	Myctophiformes	Myctophidae	Diaphus	garmani	48	formalin	FC FdB
B296	4		Bristlemouth	Stomiiformes	Phosichthyidae	Vinciguerria			RNALater, in-situ	FC FdB
		S426	anglerfish	Lophiiformes	Oneirodidae	Dolopichthys ?			glut	JM
		S427	eel larvae						RNALater	FC FdB
		S428	Ridgehead	Stephanoberyciformes	Melamphaidae				100% Eth	FC FdB
		S429	barbeled dragonfishes	Stomiiformes	Stomiidae	Eustomias		86,8	glut	FC FdB
		S430	barbeled dragonfishes	Stomiiformes	Stomiidae	Leptostomias		80	glut	FC FdB
		S431	dragonfish	Stomiiformes	Stomiidae	Photonectes ?		71,4	glut	FC FdB

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
		S432	Bristlemouth	Stomiiformes	Gonostomatidae	Gonostoma				LC
		S433	Bristlemouth	Stomiiformes	Gonostomatidae	Gonostoma				LC
B297	3		Lanternfish	Myctophiformes	Myctophidae					DW
B298	7		Hatchetfish	Stomiiformes	Sternoptychidae	Argyropeleus	hemigymnus			DW
		S434	Dragonfish	Stomiiformes	Stomiidae	Stomias	boa			SC
		S435	Dragonfish	Stomiiformes	Stomiidae	Stomias	boa			SC
		S436	Black dragonfish	Stomiiformes	Stomiidae	Idiacanthus		210	4% PFA	FC FdB
		S437	Lanternfish	Myctophiformes	Myctophidae	Diaphus	brachycephalus	31,5	formalin	FC FdB
B299			Hatchetfish	Stomiiformes	Sternoptychidae	Argyropeleus			RNALater, 4% PFA, glut	FC FdB
B300	3		Lanternfish	Myctophiformes	Myctophidae	Bolinichthys			RNALater	FC FdB
B301	2		Lanternfish	Myctophiformes	Myctophidae	Notolychnus	valvidiae		RNALater	FC FdB
		S438	Bristlemouth	Stomiiformes	Phosichthyidae	Vinciguerria			RNALater	FC FdB
		S439	squid							WS
		S440	Bristlemouth	Stomiiformes	Gonostomatidae	Gonostoma				LC
		S441	Hatchetfish	Stomiiformes	Sternoptychidae	Sternoptix				HJW
B302			eels							TL
B303			Bristlemouth	Stomiiformes	Gonostomatidae	Cyclothone				TL
		S442	Loosejaw	Stomiiformes	Stomiidae	Malacosteus	australis?	102	formalin	FC FdB
		S443	anglerfish	Lophiiformes	Melanocetidae	Melanocetus	johnsonii		formalin	FC FdB
		S444	anglerfish	Lophiiformes	Melanocetidae	Melanocetus	johnsonii		formalin	FC FdB
		S445	Rattail	Gadiformes	Macrouridae	Odontomacrurus		116,9	glut	FC FdB
		S446	anglerfish	Lophiiformes	Gigantactinidae	Gigantactis		51	glut	FC FdB
	female ?	S447	Whalefish	Cetomimiformes	Cetomimidae	Cetominus ?		70	glut	FC FdB
	male ?	S448	Whalefish	Cetomimiformes	Cetomimidae	Cetominus ?		66,6	RNALater	FC FdB
		S449	Snaggletooth	Stomiiformes	Stomiidae	Astronesthes	niger?	34,9	glut	FC FdB
		S450	Telescopefish	Aulopiformes	Giganturidae	Gigantura	indica	69,7	head 4% PFA	FC FdB

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
		S451	Crested bigscale	Stephanoberyciformes	Melamphaidae	Pomoitra	crassiceps			
		S452	Hatchetfish	Myctophiformes	Myctophidae					
		S453								
		S454	Omosudid	Aulopiformes	Omosudidae	Omosudis	lowii			
		S455	Omosudid	Aulopiformes	Omosudidae	Omosudis	lowii			
B304	6		Bristlemouth	Stomiiformes	Gonostomatidae	Cyclothone				DW
		S456	Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani			DW
B305			cephalopods							WS
		S457	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani			
		S458	Bobtail eel	Saccopharyngiformes	Cyematidae	Cyema	atrum			
		S459	Bobtail eel	Saccopharyngiformes	Cyematidae	Cyema	atrum			
		S460	Ridgehead	Stephanoberyciformes	Melamphaidae			35,5	4% PFA	FC FdB
		S461	Barracudina	Aulopiformes	Paralelipidae	Paralepis				
B306	3 heads		Hatchetfish	Stomiiformes	Sternoptychidae	Sternoptix			4% PFA in-situ	FC FdB
B307	2 babies		Hatchetfish	Stomiiformes	Sternoptychidae	Sternoptix			RNALater	FC FdB
B308			Bristlemouth	Stomiiformes	Gonostomatidae	Cyclothone	microdon			
		S462	Pearleye	Aulopiformes	Scopelarchidae	Scopelarchus		32,2	RNALater	FC FdB
		S463	Bristlemouth	Stomiiformes	Gonostomatidae	Gonostoma	elongatum			SC
		S464	Hatchetfish	Stomiiformes	Sternoptychidae	Argyropeleus	aculeatus			SC
		S465	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani			SC
		S466	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani			SC
		S467	Barreleye	Argentiniformes	Opisthoproctidae	Dolichopteryx	longipes			HJW
		S468	Hatchetfish	Stomiiformes	Sternoptychidae	Argyropeleus		72	head in-situ	FC FdB
		S469	Hatchetfish	Stomiiformes	Sternoptychidae	Argyropeleus		53,5	head in-situ	FC FdB
		S470	Hatchetfish	Stomiiformes	Sternoptychidae	Argyropeleus		47,6	head 4% PFA	FC FdB
	male	S471	Lanternfish	Myctophiformes	Myctophidae	Diaphus	brachycephalus	36,4		FC FdB
	female	S472	Lanternfish	Myctophiformes	Myctophidae	Diaphus	mollis	63	formalin	FC FdB
		S473	Lanternfish	Myctophiformes	Myctophidae	Diaphus	richarsoni	31,4	4% PFA	FC FdB

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
B309			Hatchetfish	Stomiiformes	Sternoptychidae	Argyropeleus	hemigymnius			DW
		S474	Lanternfish	Myctophiformes	Myctophidae	Triphoturus ?	nigrescence ?	49,3	4% PFA	FC FdB
	female	S475	Lanternfish	Myctophiformes	Myctophidae	Benthosema	suborbitale	25,7	4% PFA	FC FdB
	male	S476	Lanternfish	Myctophiformes	Myctophidae	Benthosema	suborbitale	23,3	4% PFA	FC FdB
S310	4		mixed lanternfish						4% PFA	FC FdB
		S477	eel larvae						head RNALater	FC FdB
		S478	Lanternfish	Myctophiformes	Myctophidae	Nannobrachium	cf nigrum	89,9	formalin	FC FdB
		S479	oreo	Zeiformes	Oreosomatidae	Oreosoma ?			RNALater	FC FdB
	baby	S480	Barreleye	Argentiniformes	Opisthoproctidae	Opisthoproctus			RNALater	FC FdB
B311	7 juveniles		mixed fish						100% Eth	FC FdB
		S481	?						4% PFA	FC FdB
		S482	Lanternfish	Myctophiformes	Myctophidae	Nannobrachium	cf nigrum			
		S483	VOID							
		S484								
		S485	Lanternfish	Myctophiformes	Myctophidae	Bolinichthys		35,14	glut	FC FdB
		S486	Pearleye	Aulopiformes	Scopelarchidae	Scopelarchus	analis			HJW
B313	8		Hatchetfish	Stomiiformes	Sternoptychidae	Argyropeleus	hemigymnius			DW
		S487	Pearleye	Aulopiformes	Scopelarchidae	Scopelarchus	analis			HJW
B314										
B315										
		S488	Loosejaw	Stomiiformes	Stomiidae	Malacosteus	australis ?			FC FdB
		S489	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani	139	in-situ	FC FdB
		S490	Bristlemouth	Stomiiformes	Gonostomatidae	Gonostoma		150		FC FdB
		S491	Bristlemouth	Stomiiformes	Gonostomatidae	Gonostoma		130		FC FdB
		S492	Bristlemouth	Stomiiformes	Gonostomatidae	Gonostoma		130	head in-situ	FC FdB
B316	bits		Lanternfish	Myctophiformes	Myctophidae					
		S493	Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani			

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
		S494	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani			
		S495	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani			
		S496	Barreleye	Argentiniformes	Opisthoproctidae	Opisthoproctus	winteria ?			HJW
		S497	Bristlemouth	Stomiiformes	Gonostomatidae	Gonostoma	elongatum			LC
		S498	Lanternfish	Myctophiformes	Myctophidae	Nannobrachium	cf. nigrum			LC
		S499	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani			LC
B317			squids							WS
		S500	Bristlemouth	Stomiiformes	Gonostomatidae	Gonostoma		133	head in-situ	FC FdB
		S501	Pearleye	Aulopiformes	Scopelarchidae	Scopelarchus	analis	40	RNALater	FC FdB
		S502	Barbeled dragonfishes	Stomiiformes	Stomiidae	Photostomias		105	4% PFA	FC FdB
		S503	Black dragonfish	Stomiiformes	Stomiidae	Idiacanthus		193	head 4% PFA	FC FdB
		S504	Black dragonfish	Stomiiformes	Stomiidae	Idiacanthus		205	head glut	FC FdB
		S505	Lanternfish	Myctophiformes	Myctophidae	Bolinichthys		60,9	glut	FC FdB
B318	9 (3x3tubes)		Lanternfish	Myctophiformes	Myctophidae	Nannobrachium	cf nigrum		in-situ, RNALater, formalin	FC FdB
B319	3		Hatchetfish	Stomiiformes	Sternoptychidae	Argyropeleus			in-situ, 4% PFA	FC FdB
B320	7		Hatchetfish	Stomiiformes	Sternoptychidae	?			RNALater, 4% PFA, glut	FC FdB
B321	2		Hatchetfish	Stomiiformes	Sternoptychidae	Argyropelecus	hemigymnius		4% PFA	FC FdB
		S506	Omosudid	Aulopiformes	Omosudidae	Omosudis	lowii			
	female	S507	Lanternfish	Myctophiformes	Myctophidae	Diaphus	brachycephalus	37,8	4% PFA	FC FdB
		S508	Lanternfish	Myctophiformes	Myctophidae	Cerastocopelus	warmingii	48,9	head in-situ	FC FdB
B322	5		mixed lanternfish	Myctophiformes	Myctophidae				4% PFA	FC FdB
B323	4		Ridgehead	Stephanoberyciformes	Melamphaidae				4% PFA	FC FdB
		S509	flying fish	Beloniformes	Exocoetidae	Exocoetus	monocirrhus	153		FC FdB
	half specimen	S510		Stomiiformes					head RNALater	FC FdB
		S511	baby cod	Gadiforme	Gadidae	Gadus		30	RNALater	FC FdB
		S512	eel larvae						head RNALater	FC FdB

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
		S513	eel						4% PFA	FC FdB
B324	4 juveniles		mixed fish						100% Eth	FC FdB
		S514								
		S515								
		S516								
		S517	Boxer snipe eel	Anguilliformes	Nemichthyidae	Nemichthys	curvirostris	143	4% PFA	TL
		S518	Hatchetfish	Stomiiformes	Sternoptychidae	Argyropelecus				HJW
		S519	Lanternfish	Myctophiformes	Myctophidae	Ceratoscopelus	warmingii	52,6	4% PFA	LC
		S520	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani	114	4% PFA	LC
		S521	Tube-eye	Gadiformes	Stylephoridae	Stylephorus	chordatus			HJW
		S522	Binocular fish	Argentiniformes	Opisthoproctidae	Winteria				HJW
B325										
B326										
B327	8		Half-naked hatchetfish	Stomiiformes	Sternoptychidae	Argyropelecus	hemigymnius			DW
B328			Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani		4% PFA	TL
B329			Bristlemouth	Stomiiformes	Gonostomatidae	Cyclothone	alba		4% PFA	TL
B330	2		Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani		4% PFA	TL
B331	2		Hatchetfish	Stomiiformes	Sternoptychidae	Argyropelecus	olfersi		4% PFA	TL
B332	2			Stomiiformes	Sternoptychidae	Valenciencellus	tripunculatus		4% PFA	SC
B333			Cephalopods							WS
		S523	Telescopefish	Aulopiformes	Giganturidae	Gigantura	chuni	75	4% PFA	SC
		S524	Tube-eye	Gadiformes	Stylephoridae	Stylephorus	chordatus		RNALater	FC FdB
		S525	Tube-eye	Gadiformes	Stylephoridae	Stylephorus	chordatus		head in-situ	FC FdB
		S526		Aulopiformes	Evermannellidae	Corrorella		56,5	4% PFA	FC FdB
		S527	Barbeled dragonfishes	Stomiiformes	Stomiidae	Aristostomias		38	4% PFA	FC FdB
	female	S528	Barreleye	Argentiniformes	Opisthoproctidae	Opisthoproctus		80		FC FdB
B334	3		Black dragonfish	Stomiiformes	Stomiidae	Idiacanthus			4% PFA, in-situ	FC FdB

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
B335	9		Silver lightfish	Stomiiformes	Phosichthyidae	Phosichthys	argenteus		4% PFA, in-situ, glut, RNALater	FC FdB
B336	5		Bristlemouth	Stomiiformes	Phosichthyidae	Vinciguerria			formalin, 100% Eth	FC FdB
B337	2		barbeled dragonfishes	Stomiiformes	Stomiidae	Eustomias			4% PFA, RNALater	FC FdB
	male	S529	Lanternfish	Myctophiformes	Myctophidae	Myctophum		59,5	formalin	FC FdB
	female	S530	Lanternfish	Myctophiformes	Myctophidae	Symbolophorus		63,6	formalin	FC FdB
B338	female 7		Lanternfish	Myctophiformes	Myctophidae	Diogenichthys			100% Eth, RNALater, glut, 4% PFA, in-situ	FC FdB
B339	male 10		Lanternfish	Myctophiformes	Myctophidae	Diogenichthys			100% Eth, RNALater, glut, 4% PFA, in-situ	FC FdB
B340	12 (2 females, 10 males)		Lanternfish	Myctophiformes	Myctophidae	Diaphus			RNALater, 4% PFA, in-situ, glut, formalin	FC FdB
B341	16		Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani		100% Eth	FC FdB
B342	3 (1 male, 2 females)		Lanternfish	Myctophiformes	Myctophidae	Diaphus			RNALater, 4% PFA	FC FdB
	from flim crew	S531	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani	143	4% PFA	TL
		S532	Flat larva	Pleuronectiformes						SC
		S535	Hatchetfish	Stomiiformes	Sternoptychidae	Argyropelecus	olfersi	58,6	4% PFA	SC
		S536	Hatchetfish	Stomiiformes	Sternoptychidae	Argyropelecus	olfersi	46	4% PFA	SC
		S537	Hatchetfish	Stomiiformes	Sternoptychidae	Argyropelecus	olfersi	40,4	4% PFA	SC
		S538								
		S542	Lanternfish	Myctophiformes	Myctophidae	Centrobranchus		36,3	4% PFA	FC FdB
B346	4		Lanternfish	Myctophiformes	Myctophidae	Bolinichthys			glut, 4% PFA, in-situ	FC FdB
B347	6		Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani		formalin	FC FdB
B349	5		Lanternfish	Myctophiformes	Myctophidae	Diaphus			RNALater, glut, 4% PFA	FC FdB
B350	lots		mixed lanternfish						formalin	FC FdB
B351	3		Lanternfish	Myctophiformes	Myctophidae	Diaphus	luetkeni		RNALater, 4% PFA	FC FdB
B352										

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
B353	3		?						RNALater, 4% PFA	FC FdB
B354	3		?						RNALater, 4% PFA	FC FdB
B355	4		Half-naked hatchetfish	Stomiiformes	Sternoptychidae	Argyropelecus	hemigymnius		100% Eth	FC FdB
B356	lots		mixed fish						formalin	FC FdB
B357	lots		mixed juvenile fish						formalin	FC FdB
		S549	Lanternfish	Myctophiformes	Myctophidae	Diaphus			4% PFA	FC FdB
		S350	Lanternfish	Myctophiformes	Myctophidae	Diaphus		48,5	4% PFA	FC FdB
		S351	barbeled dragonfishes	Stomiiformes	Stomiidae	Eustomias			RNALater	FC FdB
		S543	Pearleye	Aulopiformes	Scopelarchidae	Scopelarchus	analis			HJW
		S544	Hatchetfish	Stomiiformes	Sternoptychidae	Argyropeleus	affinis			HJW
		S545	Dragonfish	Stomiiformes	Melanostomiidae	Eustomias	schmidti	109	4% PFA	SC
		S546	Viperfish	Stomiiformes	Gonostomatidae	Bonapartia	pedaliota	56,36	4% PFA	SC
		S547	Bristlemouth	Stomiiformes	Gonostomatidae	Gonostoma				SC
		S548	Ridgehead	Stephanoberyciformes	Melamphaidae	Poromitra				SC
B343	2		Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani		4% PFA	TL
B343	3			Stomiiformes	Gonostomatidae	Diplophus	maderensis		4% PFA	SC
B344A	4		Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani		4% PFA	SC
B344B	3			Stomiiformes	Sternoptychidae	Valenciencellus	attenuata		4% PFA	SC
B345										SC
B348			Half-naked hatchetfish	Stomiiformes	Sternoptychidae	Argyropelecus	hemigymnius			DW
B359			Cephalopods							WS
		S552	Deep-sea smelt	Argentiniformes	Bathylagidae	Bathylagus		136	formalin	FC FdB
		S553	barbeled dragonfishes	Stomiiformes	Stomiidae	Eustomias			4% PFA	FC FdB
		S554	Barbeled dragonfishes	Stomiiformes	Stomiidae	Aristostomias		58,6	RNALater	FC FdB
		S555	Black dragonfish	Stomiiformes	Stomiidae	Idiacanthus		85	glut	FC FdB
		S556	? New fish??						glut	FC FdB
		S557	codlet					51,7	RNALater	FC FdB

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
B360	3 (1 male, 2 females)		Lanternfish	Myctophiformes	Myctophidae	Diaphus			4% PFA, glut	FC FdB
		S558	Herring smelt	Argentiniformes	Argentinidae	Argentina		75,6	4% PFA	FC FdB
		S559	Hatchetfish	Stomiiformes	Sternoptychidae	Argyropeleus			4% PFA	FC FdB
		S560	?						RNALater	FC FdB
		S561	baby anaplogaster?						RNALater	FC FdB
B361	2		Hatchetfish	Stomiiformes	Sternoptychidae				100% Eth	FC FdB
B362	13		Half-naked hatchetfish	Stomiiformes	Sternoptychidae	Argyropelecus	hemigymnius		100% Eth, formalin	FC FdB
B363	11		mixed lanternfish						formalin	FC FdB
neuston	female	S533	Lanternfish	Myctophiformes	Myctophidae	Myctophum	spinosum	66,1	4% PFA	LC
	male	S534	Lanternfish	Myctophiformes	Myctophidae	Myctophum		66,3	formalin	FC FdB
	male	S539	Lanternfish	Myctophiformes	Myctophidae	Symbolophorus		74	formalin	FC FdB
	female	S540	Lanternfish	Myctophiformes	Myctophidae	Symbolophorus		76,3	formalin	FC FdB
	female	S541	Lanternfish	Myctophiformes	Myctophidae	Symbolophorus		75,11	formalin	FC FdB
B358	lots		lanternfish juveniles						formalin	FC FdB
		S562	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani	124,33	4% PFA	LC
		S563	Lightfish	Stomiiformes	Phosichthyidae	Ichthyococcus	ovatus			HJW
		S564	Lightfish	Stomiiformes	Gonostomatidae	Diplophus	maderensis	63,9	4% PFA	SC
B364	4		Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani		4% PFA	SC
B365	2			Stomiiformes	Sternoptychidae	Valenciencellus	tripunctulatus		4% PFA	SC
B366	7		Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani		4% PFA, 100% Eth	FC FdB
B367			cephalopods							WS
		S565	Tube-eye	Gadiformes	Stylephoridae	Stylephorus	chordatus	85	glut	FC FdB
		S566	Loosejaw	Stomiiformes	Stomiidae	Malacosteus		36,6	in-situ	FC FdB
		S567		Stomiiformes	Sternoptychidae	Valenciencellus	attenuata	35,1	4% PFA	SC
		S568	Barbeled dragonfishes	Stomiiformes	Stomiidae	Photostomias		62,2	4% PFA	FC FdB

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
		S569	Black dragonfish	Stomiiformes	Stomiidae	Idiacanthus		61,7	100% Eth	FC FdB
	female	S570	Lanternfish	Myctophiformes	Myctophidae	Diaphus		42,8	glut	FC FdB
	male	S571	Lanternfish	Myctophiformes	Myctophidae	Diaphus	mollis ?	80	4% PFA (in same tube)	FC FdB
	female	S572	Lanternfish	Myctophiformes	Myctophidae	Diaphus	mollis ?	74,4		
B368	2		Lanternfish	Myctophiformes	Myctophidae	Diaphus		30,7	4% PFA	FC FdB
B369	2		Lanternfish	Myctophiformes	Myctophidae	Diaphus		52, 49	4% PFA	FC FdB
		S573	Lanternfish	Myctophiformes	Myctophidae	Diaphus		63	4% PFA	FC FdB
		S574	Lanternfish	Myctophiformes	Myctophidae	Diaphus		60	4% PFA	FC FdB
		S575	Lanternfish	Myctophiformes	Myctophidae	Hygophum ?			4% PFA	FC FdB
		S576	Lanternfish	Myctophiformes	Myctophidae	Lampadena ?			4% PFA	FC FdB
B370	15		mixed juvenile lanternfish	Myctophiformes	Myctophidae				formalin	FC FdB
B371	5		mixed lanternfish	Myctophiformes	Myctophidae				formalin	FC FdB
B372	2		Lanternfish	Myctophiformes	Myctophidae	Diaphus			RNALAter, 4% PFA	FC FdB
		S578	Bristlemouth	Stomiiformes	Gonostomatidae	Cyclothone			100% Eth	FC FdB
	juvenile	S579	Fangtooth			Anaplogaster			glut	FC FdB
neuston	male	S577	Lanternfish	Myctophiformes	Myctophidae	Symbolophorus	rufinus	70,6	formalin	FC FdB
neuston	male	S580	Lanternfish	Myctophiformes	Myctophidae	Symbolophorus	rufinus	64,8	formalin	FC FdB
B373	3 juveniles		Lanternfish	Myctophiformes	Myctophidae	1 Myctophum, 2 Symbolophorus			4% PFA	FC FdB
		S581	Crested bigscale	Stephanoberyciformes	Melamphaidae	Poromitra	crassiceps	55,9	4% PFA	LC
		S582	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani			LC
		S583	Lanternfish	Myctophiformes	Myctophidae	Ceratoscopelus	warmingii	60,9	4% PFA	LC
		S584	Bristlemouth	Stomiiformes	Gonostomatidae	Gonostoma	elongatum		4% PFA	LC
		S585	Crested bigscale	Stephanoberyciformes	Melamphaidae	Poromitra	crassiceps		4% PFA	LC

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
		S586	Half-naked hatchetfish	Stomiiformes	Sternoptychidae	Argyropelecus	hemigymnius			HJW
		S587	Half-naked hatchetfish	Stomiiformes	Sternoptychidae	Argyropelecus	hemigymnius			HJW
		S588	Half-naked hatchetfish	Stomiiformes	Sternoptychidae	Argyropelecus	hemigymnius			HJW
		S589	Pearleye	Aulopiformes	Scopelarchidae	Scopelarchus	analis			HJW
		S590	Tube-eye	Gadiformes	Stylephoridae	Stylephorus	chordatus			HJW
		S591	Thread-tail	Lampridiformes	Stylephoridae	Stylephorus	chordatus	194	4% PFA	SC
		S592A	Crested bigscale	Stephanoberyciformes	Melamphaidae	Poromitra	crassiceps	25,6	4% PFA	SC
		S592B	Bristlemouth	Stomiiformes	Stomiidae	Gonostoma	elongatum	228	4% PFA	SC
		S594A	Crested bigscale	Stephanoberyciformes	Melamphaidae	Poromitra	crassiceps	87,4	4% PFA	SC
		S594B	Bauer's dragonfish	Stomiiformes	Stomiidae	Photonectes	braueri	190	4% PFA	SC
B374	2		Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani		4% PFA	SC
B375	4			Stomiiformes	Gonostomatidae	Diplophus	maderensis		4% PFA	SC
B376			cephalopods							WS
B377	24		Half-naked hatchetfish	Stomiiformes	Sternoptychidae	Argyropelecus	hemigymnius			DW
		S595	Boxer snipe eel	Anguilliformes	Nemichtyidae	Nemichthys	curvirostris		4% PFA	TL
		S596	whalefish?					63	glut	JM
		S597	Whalefish	Cetomimiformes	Rondeletiidae	Rondeletia		32,2	glut	JM
		S598	Tube-eye	Gadiformes	Stylephoridae	Stylephorus	chordatus	195	4% PFA	FC FdB
		S599	Barbeled dragonfishes	Stomiiformes	Stomiidae	Photostomias		132,9	formalin	FC FdB
		S600	Dragonfish	Stomiiformes	Stomiidae	Stomias	boa	78	4% PFA	TL
B378	2		eels						glut	FC FdB
B379	lots			Stomiiformes		Gonostoma + Chaliodus			RNALater, 4% PFA, glut, formalin	FC FdB
B380			Ridgehead	Stephanoberyciformes	Melamphaidae				formalin	FC FdB
		S601	Herring smelt	Argentiniformes	Argentinidae	Argentina		140		FC FdB
B381	4		hatchetfish	Stomiiformes	Sternoptychidae				100% Eth	FC FdB
B382	5		Ridgehead	Stephanoberyciformes	Melamphaidae				100% Eth	FC FdB
		S602	eel larvae						head RNALater	FC FdB

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
		S603	?							FC FdB
		S604	John Dori	Zeiformes	Zeidae	Zeus	faber		100% Eth	FC FdB
	male	S605	Lanternfish	Myctophiformes	Myctophidae	Symbolophorus	evermanni	40,24	4% PFA	FC FdB
		S606	Lanternfish	Myctophiformes	Myctophidae	Diaphus	luetkeni	47	4% PFA	FC FdB
B383	8		mixed lanternfish						formalin	FC FdB
		S607	Deep-sea smelt	Argentiniformes	Bathylagidae	Bathylagus		62,1	4% PFA	FC FdB
		S608	Fangtooth	Berviciformes	Anoplogasteridae	Anoplogastes	corniuta	37,4	4% PFA	SC
		S609	Swallower	Perciformes	Chiasmodontidae	Chiasmodon	subniger	66,7	4% PFA	SC
		S610	Barbeled dragonfishes	Stomiiformes	Stomiidae	Melanostomias	bartonbeani	230	formalin	FC FdB
		S611	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani	173	4% PFA	LC
		S612	Lanternfish	Myctophiformes	Myctophidae	Ceratoscopelus	warmingii	62	4% PFA	LC
		S613	Lanternfish	Myctophiformes	Myctophidae	Ceratoscopelus	warmingii	25,9	4% PFA	LC
		S614	Pearleye	Aulopiformes	Scopelarchidae	Scopelarchus				HJW
	male	S615	Lanternfish	Myctophiformes	Myctophidae	Myctophum	spinosum?	49,7	formalin	FC FdB
	male	S616	Lanternfish	Myctophiformes	Myctophidae	Symbolophorus	rufinus	58,6	formalin	FC FdB
		S617	Risso's smooth-head	Clupeiformes	Alepocephalidae	Alepocephalus	rostratus	99	4% PFA	SC
		S618		Gadiformes	Melanonidae	Melanonus	zygmayeri	207	4% PFA	SC
		S619	Snaggletooths	Stomiiformes	Stomiidae	Astronesthes	sp	178	4% PFA	FC FdB
	female	S620	Lanternfish	Myctophiformes	Myctophidae	Symbolophorus	rufinus	48,8	formalin	FC FdB
	juvenile	S621	Lanternfish	Myctophiformes	Myctophidae	Myctophum	spinosum			SC
		S622	Swallower	Perciformes	Chiasmodontidae	Chiasmodon	microcephalus	85,9	4% PFA	SC
		S623	Dragonfish	Stomiiformes	Stomiidae	Fagellostomias	boureei	139	4% PFA	SC
		S624	Thread-tail	Lampridiformes	Stylephoridae	Stylephorus	chordatus	245	4% PFA	SC
		S625		Stomiiformes	Gonostomatidae	Diplophus	maderensis		4% PFA	SC
		S626	Omosudid	Aulopiformes	Paralepididae	Omosudis	lowii	34,22	4% PFA	SC
		S627	Barracudina	Aulopiformes	Paralepididae	Paralepis	brevirostris	37,06	4% PFA	SC

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
		S628		Clupeiformes	Alepocephalidae	Bathylaco	sp	315	4% PFA	SC
		S629	Crested bigscale	Stephanoberyciformes	Melamphaidae	Poromitra	crassiceps	80,5	4% PFA	SC
		S630								
		S631	Boxer snipe eel	Anguilliformes	Nemichthyidae	Nemichthys	curvirostris		4% PFA	TL
B384			Cephalopods							WS
	female	S632	Lanternfish	Myctophiformes	Myctophidae	Symbolophorus	evermanni	51,5	formalin	FC FdB
	female	S633	Anglerfish	Lophiiformes	Oneirodidae	Oneirodes		53,3	formalin	FC FdB
	male	S634	Anglerfish	Lophiiformes	Himantolophidae	Himantolophus		22,4	4% PFA	FC FdB
	juvenile male?	S635	Anglerfish	Lophiiformes	Ceratiidae	Ceraties		21	RNALater	FC FdB
		S636	Dragonfish	Stomiiformes	Stomiidae	Melanostomias ?		148	formalin	FC FdB
		S637		Myctophiformes	Neoscopelidae	Scopelengis	tristis	170	formalin	FC FdB
		S638	Loosejaw	Stomiiformes	Stomiidae	Malacosteus	niger	132	head 4% PFA	FC FdB
		S639	Loosejaw	Stomiiformes	Stomiidae	Malacosteus	niger	83	head glut	FC FdB
		S640	barbeled dragonfishes	Stomiiformes	Stomiidae	Eustomias			RNALater	FC FdB
		S641	barbeled dragonfishes	Stomiiformes	Stomiidae	Eustomias		51	RNALater	FC FdB
B385	6		mixed stomiiformes						4% PFA	FC FdB
B386	10		Hatchetfish	Stomiiformes	Sternoptychidae	Sternoptix			100% Eth	FC FdB
B387	2		Hatchetfish	Stomiiformes	Sternoptychidae	Argyropelecus			100% Eth	FC FdB
		S642	Bristlemouth	Stomiiformes	Phosichthyidae	Vinciguerria			100% Eth	FC FdB
		S643	Swallower	Perciformes	Chiasmodontidae	Chiasmodon		34,5	4% PFA	FC FdB
		S644	?					19,2	RNALater	FC FdB
	juvenile	S645	Slickhead	Argentiniformes	Alepocephalidae	Alepocephalus	rostratus	30,2	RNALater	FC FdB
		S646	rattail					100	formalin	FC FdB
		S647		Myctophiformes	Neoscopelidae	Scopelengis	tristis	94,8	formalin with S637	FC FdB
B388	2		Lanternfish	Myctophiformes	Myctophidae	Ceratoscopelus	warmingii	48.4, 51.7	2 heads glut	FC FdB
B389	23		mixed lanternfish						formalin	FC FdB
		S648	Lanternfish	Myctophiformes	Myctophidae	Diaphus	luetkeni	46,1	head glut	FC FdB

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
		S649	Lanternfish	Myctophiformes	Myctophidae	Lampadena ?		36	4% PFA	FC FdB
		S650	Cusk-eel	Ophidiiformes	Ophidiidae	Barathrites	iris		formalin	AJ
		S651	Cusk-eel	Ophidiiformes	Ophidiidae	Barathrites	iris		formalin	AJ
B390	10		Half-naked hatchetfish	Stomiiformes	Sternoptychidae	Argyropelecus	hemigymnius			DW
		S652	Dragonfish	Stomiiformes	Stomiidae	Stomias	boa	170	4% PFA	LC
B391	2		Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani		4% PFA	TL
B392	3		Leptocephalus eel larvae	Anguilliformes	Congridae?				4% PFA	TL
		S653	Snaggletooths	Stomiiformes	Astronesthidae	Astronesthes	macropogon	33,8	4% PFA	SC
		S654	Thread-tail	Lampridiformes	Stylephoridae	Stylephorus	chordatus	130	4% PFA	SC
		S655	Atlantic sabretooth	Aulopiformes	Evermannellidae	Coccorella	atlantica	39,4	4% PFA	SC
B393	3					Diplophos	maderensis			HJW
B394	4		mixed stomiiformes			4 Eustomias, 1 Photonectes, 1 Photostomias			4% PFA	FC FdB
B395	4		Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani		4% PFA	TL
B396	3		Lanternfish	Myctophiformes	Myctophidae	Diaphus	sp		4% PFA	TL
	male	S656	Lanternfish	Myctophiformes	Myctophidae	Myctophum	nitidulum	58	formalin	FC FdB
		S657	Tube-eye	Gadiformes	Stylephoridae	Stylephorus	chordatus	139	head in-situ	FC FdB
		S658	Tube-eye	Gadiformes	Stylephoridae	Stylephorus	chordatus	150	head RNALalter	FC FdB
		S659	Snaggletooths	Stomiiformes	Stomiidae	Astronesthes		78,2	4% PFA	FC FdB
		S660	Snaggletooths	Stomiiformes	Stomiidae	Astronesthes		49,4	4% PFA	FC FdB
		S661	ask Fab					23,33	RNALater	FC FdB
		S662	Lanternfish	Myctophiformes	Myctophidae	Lampanyctus	sp	73,9	4% PFA	TL
		S663	Lanternfish	Myctophiformes	Myctophidae	Lampadena		47,6	4% PFA	FC FdB
	male	S664	Lanternfish	Myctophiformes	Myctophidae	Hygophum		35,8	formalin	FC FdB
B397	20		Lanternfish	Myctophiformes	Myctophidae	Diaphus			RNALater, 4% PFA, glut, in-situ	FC FdB
B398										

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
B399	2		Lanternfish	Myctophiformes	Myctophidae	Diogenichthys			100% Eth	FC FdB
B400	115		mixed lanternfish						formalin	FC FdB
	male	S665	Lanternfish	Myctophiformes	Myctophidae	Hygophum		31,6	4% PFA	FC FdB
		S666	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani	121	4% PFA	LC
		S667	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani	130,8	4% PFA	LC
		S668	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani		4% PFA	LC
		S669	Snaggletooth	Stomiiformes	Astronesthidae	Astronesthes	macropogon		4% PFA	LC
		S670	Tube-eye	Gadiformes	Stylephoridae	Stylephorus	chordatus			HJW
B401			Hatchetfish	Stomiiformes	Sternoptychidae					DW
B402	2		Thread-tail	Lampridiformes	Stylephoridae	Stylephorus	chordatus		4% PFA	SC
B403	3		Leptocephalus eel larvae	Anguilliformes					4% PFA	SC
B404	2		Slender snipe eel	Anguilliformes	Nemichthyidae	Nemichthys	scolopaceus		4% PFA	SC
B405	3		Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani		4% PFA	SC
		S671	Swallower	Perciformes	Chiasmodontidae	Pseudoscopelus	altipinnis	51,9	4% PFA	SC
		S672		Stomiiformes	Photichthyidae	Ichthyococcus	ovatus	36,6	4% PFA	SC
B406			Cephalopods							WS
		S673	Loosejaw	Stomiiformes	Stomiidae	Malacosteus	niger	100	4% PFA	FC FdB
		S674	Loosejaw	Stomiiformes	Stomiidae	Malacosteus	niger	80	in situ	FC FdB
		S675	Loosejaw	Stomiiformes	Stomiidae	Malacosteus	niger	59	glut	FC FdB
		S676	Loosejaw	Stomiiformes	Stomiidae	Malacosteus	niger	45	RNALater	FC FdB
		S677	barbeled dragonfishes	Stomiiformes	Stomiidae	Leptostomias		160	formalin	FC FdB
		S678	barbeled dragonfishes	Stomiiformes	Stomiidae	Eustomias		145		FC FdB
		S679	barbeled dragonfishes	Stomiiformes	Stomiidae	Eustomias		125	formalin	FC FdB
		S680	barbeled dragonfishes	Stomiiformes	Stomiidae	Eustomias		111	head in situ	FC FdB
B407	5		barbeled dragonfishes	Stomiiformes	Stomiidae	Eustomias			4% PFA	FC FdB
		S681	Barbeled dragonfishes	Stomiiformes	Stomiidae	Photostomias		52	4% PFA	FC FdB
		S682	Loosejaw	Stomiiformes	Stomiidae	Malacosteus	australia	40	4% PFA	FC FdB

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
		S683	Snaggletooths	Stomiiformes	Stomiidae	Astronesthes		70	4% PFA	FC FdB
		S684	Loosejaw	Stomiiformes	Stomiidae	Malacosteus	niger	70	4% PFA	FC FdB
		S685	Baby batfish						glut	FC FdB
		S686	long eel with big eyes						formalin	FC FdB
		S687	long eel with big eyes							FC FdB
		S688		Myctophiformes	Neoscopelidae	Scopelengys	tristis		head RNALater	FC FdB
		S689	mini stomiiforme						4% PFA	FC FdB
		S690	?						4% PFA	FC FdB
		S691	Loosejaw	Stomiiformes	Stomiidae	Malacosteus	niger		4% PFA	FC FdB
B408	40		Misex lanternfish						formalin	FC FdB
		S692	fat eel larvae							
		S693	Hatchetfish	Stomiiformes	Sternoptychidae	Argyropeleus	affinis			HJW
		S694	Sabertooth fish	Aulopiformes	Evermannellidae	Evermannella	indica			HJW
		S695	Anglerfish	Lophiiformes	Thaumatichthyidae	Lasiognathus		130	formalin	FC FdB
		S696	Lanternfish	Myctophiformes	Myctophidae	Lampadena	urophaos	147	formalin	FC FdB
		S697	Gadiform	Gadiformes	Melanonidae	Melanonus	zukmeri	200	formalin	FC FdB
		S698	Loosejaw	Stomiiformes	Stomiidae	Malacosteus	niger	146	head in-situ	FC FdB
		S699	Loosejaw	Stomiiformes	Stomiidae	Malacosteus	niger	78	head RNALater	FC FdB
		S700	Loosejaw	Stomiiformes	Stomiidae	Malacosteus	niger	90	head in-situ	FC FdB
		S701	Loosejaw	Stomiiformes	Stomiidae	Malacosteus	niger	96	head 4% PFA	FC FdB
B409	18		Hatchetfish mix						formalin	FC FdB
B410	5		eel larvae						formalin	FC FdB
B411	3			Myctophiformes	Neoscopelidae	Scopelengys	tristis		head RNALater, 4% PFA, glut	FC FdB
B412	4		Loosejaw	Stomiiformes	Stomiidae	Malacosteus	niger		4% PFA	SC
		S702	Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani		4% PFA	SC
		S703	Telescopefish	Aulopiformes	Giganturidae	Gigantura	chuni	63	4% PFA	SC
B413	11		Snipe eel	Anguilliformes	Nemichthyidae	Avocettina	acuticeps?		4% PFA	SC
		S704	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani	208	4% PFA	SC

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
		S705		Gadiformes	Melanonidae	Melanonus	zygmayeri	240	4% PFA	SC
		S706	Larval flatfish	Pleuronectiformes					4% PFA	SC
		S707	Sabertooth fish	Aulopiformes	Evermannellidae	Evermannella	indica			HJW
B414			Cephalopods							WS
		S708	Loosejaw	Stomiiformes	Stomiidae	Malacosteus	niger			HJW
		S709	Loosejaw	Stomiiformes	Stomiidae	Malacosteus	australis ?			HJW
		S710	Barbeled dragonfish	Stomiiformes	Stomiidae	Borostomias		125	formalin	FC FdB
		S711	Barbeled dragonfish	Stomiiformes	Stomiidae	Borostomias		87	formalin	FC FdB
		S712	Black dragonfish	Stomiiformes	Stomiidae	Idiacanthus		267	formalin	FC FdB
		S713	Barbeled dragonfish	Stomiiformes	Stomiidae	Borostomias		83	head in-situ	FC FdB
		S714	anglerfish	Lophiiformes	Melanocetidae	Melanocetus	johnsonii		glut	JM
	baby	S715	anglerfish	Lophiiformes	Melanocetidae	Melanocetus	johnsonii			JM
		S716	anglerfish	Lophiiformes	Ceratiidae	Cryptopsaras	couesii		formalin	JM
		S717	whalefish						head RNALater	FC FdB
		S718	Snaggletooths	Stomiiformes	Stomiidae	Astronesthes		40	glut	FC FdB
		S719	snipe eel						head RNALater	FC FdB
		S720	snipe eel						head RNALater	FC FdB
		S721	codlet	Gadiformes	Bregmacerotidae	Bregmaceros		60	formalin	FC FdB
		S722	rattail					100	glut	JM
		S723	?					43	formalin	FC FdB
B415	2		batfish juveniles						glut	JM
B416	4		barbeled dragonfishes	Stomiiformes	Stomiidae	Eustomias			formalin	FC FdB
B417	2		Melamphase						100% Eth	FC FdB
B418	5		Lanternfish	Myctophiformes	Myctophidae	Taanigichthys			4% PFA	FC FdB
		S724	Lanternfish	Myctophiformes	Myctophidae	Lampadena	luminosa	48	4% PFA	FC FdB
		S725	Lanternfish	Myctophiformes	Myctophidae	Lampanyctus?			4% PFA	SC
B419	2		Lanternfish	Myctophiformes	Myctophidae	Diaphus		105, 68	formalin	FC FdB
B420A	23		Mixed lanternfish						formalin	FC FdB
		S726	Bean's sawtooth eel	Anguilliformes	Nemichthyidae	Serrivomer	beani		4% PFA	SC

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
		S727	Larvae	Lampridiformes	Trachipteridae?				4% PFA	SC
		S728	Snipe eel	Anguilliformes	Nemichthyidae	Avocettina	acuticeps?		4% PFA	SC
		S729	Oceanic lightfish	Stomiiformes	Phosichtyidae	Vinciguerria	nimbaria	32,25	4% PFA	SC
		S730	Larvae / metamorphic snipe eel	Anguilliformes	Nemichthyidae	Nemichthys			4% PFA	SC
		S731	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani	245	4% PFA	SC
B420B	2		Eyebrow bigscale	Stephanoberyciformes	Melamphaidae	Melamphaes	longivelis		4% PFA	SC
B421			Cephalopods							WS
B422			Hatchetfish	Stomiiformes	Sternoptychidae	Sternoptyx				JM
B423			eel larvae						formalin	JM
B424	16		Hatchetfish	Stomiiformes	Sternoptychidae	Sternoptyx	diaphana		formalin	HJW
		S732	Barbeled dragonfishes	Stomiiformes	Stomiidae	Photostomias		110	heat glut	FC FdB
		S733	Barreleye	Argentiniformes	Opisthoproctidae	Opisthoproctus				HJW
		S734	Gulper eel	Saccopharyngiformes	Eurypharyngidae	Eurypharynx	pelecanoides		formalin	FC FdB
	male	S735	anglerfish	Lophiiformes					RNALater	FC FdB
		S736	Loosejaw	Stomiiformes	Stomiidae	Malacosteus	niger	170	formalin	FC FdB
		S737	Barbeled dragonfishes	Stomiiformes	Stomiidae	Neonesthes		180		FC FdB
		S738A	Snaketooth fish	Perciformes	Chiasmodontidae	Kali	microdon ?	200	?	?
		S738B	Snipe eel	Anguilliformes	Nemichthyidae	Avocettina	acuticeps?		4% PFA	TL
		S739	Barbeled dragonfish	Stomiiformes	Stomiidae	Borostomias		135	head 4% PFA	FC FdB
		S740		Gadiformes	Melanonidae	Melalonus	zymazeri	193	4% PFA	SC
		S741	Snaketooth fish	Perciformes	Chiasmodontidae	Chiasmodon		37,5	4% PFA	FC FdB
		S742	codlet	Gadiformes	Bregmacerotidae	Bregmaceros		49,5	RNALater	FC FdB
		S743	Snaketooth fish	Perciformes	Chiasmodontidae	Chiasmodon		60	?	FC FdB
		S744	Lanternfish	Myctophiformes	Myctophidae	Diaphus		162	4% PFA	FC FdB
		S745			Alepocephalidae			34,5	4% PFA	FC FdB
		S746	anglerfish	Lophiiformes	Ceratiidae	Cryptopsaras	couesii		formalin	JM
		S747	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani			TL
B425	4		anglerfish	Lophiiformes					formalin	JM

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
B426	32		Hatchetfish	Stomiiformes	Sternoptychidae	Sternoptyx				DW
B427	4		Lanternfish	Myctophiformes	Myctophidae	Cerastocopelus	warmingii		RNALater, 4% PFA	FC FdB
B428	2		Lanternfish	Myctophiformes	Myctophidae	Taanigichthys			in-situ, glut	FC FdB
		S748	Lightfish	Stomiiformes	Phosichthyidae	Ichthyococcus	ovatus			HJW
		S753	Barbeled dragonfish	Stomiiformes	Stomiidae	Eustomias	grandibulbus	131,2	4% PFA	LC
		S754	Barbeled dragonfish	Stomiiformes	Stomiidae	Eustomias	grandibulbus	127,1	4% PFA	LC
		S755	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani	38,89	4% PFA	SC
		S756		Stomiiformes	Stomiidae	Photonectes	parvimanus	90	4% PFA	SC
		S757		Aulopiformes	Evermannellidae	Odontostomops	normalops	42,63	4% PFA	SC
		S758		Aulopiformes	Evermannellidae	Odontostomops	normalops	38,89	4% PFA	SC
		S759	Sabertooth fish	Aulopiformes	Evermannellidae	Evermannella	indica			HJW
		S760	Loosejaw	Stomiiformes	Stomiidae	Malacosteus	australis ?			HJW
B429										
B430	5		barbeled dragonfishes	Stomiiformes	Stomiidae	Eustomias	grandibulbus		4% PFA	SC
B431	15		Hatchetfish	Stomiiformes	Sternoptychidae	Argyropeleus				HJW
B432	3		Lightfish	Stomiiformes	Phosichthyidae	Ichthyococcus	ovatus			HJW
B433	3		Pearleye	Aulopiformes	Scopelarchidae	Scopelarchus			4% PFA, glut, in-situ	FC FdB
B434	5		barbeled dragonfishes	Stomiiformes	Stomiidae	Eustomias			4% Pfa	FC FdB
B435	4		codlet	Gadiformes	Bregmacerotidae	Bregmaceros			RNALater, 4% PFA	FC FdB
B436	3		eel Larvae						formalin	FC FdB
B437	4 juveniles		Lanternfish	Myctophiformes	Myctophidae	Symbolophorus			4% PFA	FC FdB
B438	5 males		Lanternfish	Myctophiformes	Myctophidae	Diaphus			RNALater, 4% PFA, glut, in-situ	FC FdB
B439	4 females		Lanternfish	Myctophiformes	Myctophidae	Diaphus			RNALater, 4% PFA, glut, in-situ	FC FdB
B440	37		Mixed lanternfish						formalin	FC FdB
B441			Cephalopods							WS

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
		S761	Sabertooth fish	Aulopiformes	Evermannellidae	Evermannella		50,9	4% PFA	FC FdB
		S762	Barbeled dragonfishes	Stomiiformes	Stomiidae	Photostomias		146	head in-situ	FC FdB
		S763	?						RNALater	FC FdB
		S764		Stomiiformes	Stomiidae	Photonectes			4% PFA	FC FdB
		S765	Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani	160	4% PFA	SC
		S766	Lightfish	Stomiiformes	Phosichthyidae	Ichthyococcus	ovatus	31	4% PFA	TL
B442			Hatchetfish	Stomiiformes	Sternoptychidae	Argyropeleus				HJW
B443			Hatchetfish	Stomiiformes	Sternoptychidae	Sternoptyx	diaphana			HJW
B444	12		Hatchetfish	Stomiiformes	Sternoptychidae	Argyropeleus	hemigymnus			DW
		S767	Lanternfish	Myctophiformes	Myctophidae	Lampanyctus	festivus?	54,86	4% PFA	LC
		S768	Barreleye	Argentiniformes	Opisthoproctidae	Dolichopteryx	sp			HJW
		S769	Telescopefish	Aulopiformes	Giganturidae	Gigantura	indica			HJW
		S770	Lanternfish	Myctophiformes	Myctophidae	Diaphus	regani	47,26	4% PFA	LC
		S771	Lanternfish	Myctophiformes	Myctophidae	Bolinichtys	longipes	39,31	4% PFA	LC
		S772	Pearleye	Aulopiformes	Scopelarchidae	Scopelarchus				HJW
		S773	Lanternfish	Myctophiformes	Myctophidae	Lampanyctus	vadulus	49,69	4% PFA	SC
B445	3		Viperfish	Stomiiformes	Stomiidae	Chauliodus	sloani		4% PFA	SC
		S774		Stephanoberyciformes	Melamphaidae	Melamphaes	longivelis	69,6	4% PFA	SC
		S775	Larva / metamorphic eel	Anguilliformes	Nemichthyidae	Nemichthys	curvirostris?		4% PFA	SC
		S776	Eel	Anguilliformes	Nemichthyidae	Nemichthys	scolopaceus		4% PFA	SC
		S777	Loosejaw	Stomiiformes	Stomiidae	Malacosteus	niger	92	4% PFA	SC
		S778	Bristlemouth	Stomiiformes	Gonostomatidae	Gonostoma	elongatum	57	4% PFA	SC
B446	9		Mixed stomiiformes			2 Gonostoma, 7 Chauliodus			formalin	FC FdB
		S779	John Dori	Zeiformes	Zeidae	Zeus	faber	110		FC FdB
		S780	eel						head RNALater	FC FdB
		S781		Stomiiformes	Stomiidae	Stomias		95,4	4% PFA	FC FdB
		S782	Telescopefish	Aulopiformes	Giganturidae	Gigantura	indica	103,5	head in situ	FC FdB

Appendix V (Teleost Fish Recovered from Trawls)

Batch Number	Number of animals	Sample Number	Common Name	Order	Family	Genus	Species	Standard Length (mm)	Fixation	Custodian
		S783	?					94	4% PFA	FC FdB
B447	3		barbeled dragonfishes	Stomiiformes	Stomiidae	Eustomias			4% PFA	FC FdB
B448	4		Ridgehead	Stephanoberyciformes	Melamphaidae	Poromitra	crassiceps		formalin	FC FdB
B449	2			Stomiiformes	Stomiidae	Stomias	affinis?		4% PFA	SC
B450	3	eel larvae							formalin	FC FdB
		S784	Barbeled dragonfishes	Stomiiformes	Stomiidae	Photostomias	quernei			HJW
		S785	Lanternfish	Myctophiformes	Myctophidae	Lampanyctus		66,2	4% PFA	FC FdB
		S786	Snaggletooths	Stomiiformes	Stomiidae	Astronesthes		36,5	in-situ	FC FdB
	juvenile	S787	Lanternfish	Myctophiformes	Myctophidae	Symbolophorus			4% PFA	FC FdB
		S788	Lanternfish	Myctophiformes	Myctophidae	Lampadena		49,9	4% PFA	FC FdB
		S789	Risso's smooth-head	Clupeiformes	Alepocephalidae	Alepocephalus	rostratus	38,83	4% PFA	SC
		S790	Silver lightfish	Stomiiformes	Phosichthyidae	Phosichthys	argenteus		RNALater	FC FdB
B451			Cephalopods							WS
B452	31		Lanternfish mix							FC FdB

Appendix VI (Cephalopods Recovered from Trawls)

Octopodiforms	**Family**	**Genus**	**Species**	**Individuals**
	5	**6**	**6**	**61**
	Amphitretidae	*Amphitretus*	*A. pelagicus*	5
	Argonautidae	*Argonauta*	*A. argo*	1
	Bolitaenidae	*Japetella*	*J. diaphana*	34
		Bolitaena	*B. pygmaea*	8
	Vampyroteuthidae	*Vampyroteuthis*	*V. infernalis*	6
	Vitreledonellidae	*Vitreledonella*	*V. richardi*	7

Decapodiforms	**Family**	**Genus**	**Species**	**Individuals**
	12	**21**	**23 (+4 unable to id)**	**164**
	Ancistrocheiridae	*Ancistrocheirus*	*A. lesueuri*	1
	Bathyteuthidae	*Bathyteuthis*	*B. abyssicola*	6
		Bathyteuthis	*black form*	4
	Chiroteuthidae	*Chiroteuthis*	*sp*	9
	Cranchidae	*Bathothauma*	*B. lyromma*	13
		Cranchia	*C. scabra*	5
		Helicocranchia	*sp*	17
		Leachia	*sp*	3
		Liocranchia	*sp*	9
		Sandalops	*S. melancholicus*	4
		Teuthowenia	*sp*	5
		Cranchid larvae	*multiple species*	25
	Enoploteuthidae	*Enoploteuthis*	*sp*	3
		Abralia	*sp*	1
		Abraliopsis	*sp*	6
	Histioteuthidae	*Histioteuthis*	*H.hoylei*	13
		Histioteuthis	*H. meleagroteuthis*	1
	Mastigoteuthidae	*Mastigoteuthis*	*sp*	1
	Octopoteuthidae	*Octopoteuthis*	*O. sicula*	2
	Ommastrephidae		*larva*	1
		Sthenoteuthis	*S. oualaniensis*	10
	Onychoteuthidae	*Onychoteuthis*	*sp*	2
	Pyroteuthidae	*Pterygioteuthis*	*sp*	2
		Pyroteuthis	*sp*	8
	Spirulidae	*Spirula*	*S. spirula*	2
	unable identified	squid larvae		11

Appendix VII (Shrimp Caught or Used for Crustacean Experiments)

Visual Physiology Experiments:
1 Acanthephyra pelagica (Oplophoridae)
9 Plesionika sp. (Pandalidae)
1 Systellaspis debilis

Photophore Physiology Experiments:
10 *Sergestes sp.*
2 Systellaspis debilis
1 Oplophorus gracilirostris1
1 Janicella spinacauda

Population Genetics Experiments (RNA later):
13 *Oplophorus gracilirostris*
5 Systellaspis debilis
5 Systellaspis braueri
10 Acanthephyra stylorostratis
2 Acanthephyra smithi
8 Hymenodora sp.
2 Janicella spinacauda
12 Sergia
3 Plesionika

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GEOMAR Reports

No.	Title
1	FS POSEIDON Fahrtbericht / Cruise Report POS421, 08. – 18.11.2011, Kiel - Las Palmas, Ed.: T.J. Müller, 26 pp, DOI: 10.3289/GEOMAR_REP_NS_1_2012
2	Nitrous Oxide Time Series Measurements off Peru – A Collaboration between SFB 754 and IMARPE –, Annual Report 2011, Eds.: Baustian, T., M. Graco, H.W. Bange, G. Flores, J. Ledesma, M. Sarmiento, V. Leon, C. Robles, O. Moron, 20 pp, DOI: 10.3289/GEOMAR_REP_NS_2_2012
3	FS POSEIDON Fahrtbericht / Cruise Report POS427 – Fluid emissions from mud volcanoes, cold seeps and fluid circulation at the Don-_Kuban deep sea fan (Kerch peninsula, Crimea, Black Sea) – 23.02. – 19.03.2012, Burgas, Bulgaria - Heraklion, Greece, Ed.: J. Bialas, 32 pp, DOI: 10.3289/GEOMAR_REP_NS_3_2012
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5	RV PELAGIA Fahrtbericht / Cruise Report 64PE350/64PE351 – JEDDAH-TRANSECT -, 08.03. – 05.04.2012, Jeddah – Jeddah, 06.04 - 22.04.2012, Jeddah – Duba, Eds.: M. Schmidt, R. Al-Farawati, A. Al-Aidaroos, B. Kürten and the shipboard scientific party, 154 pp, DOI: 10.3289/GEOMAR_REP_NS_5_2013
6	RV SONNE Fahrtbericht / Cruise Report SO225 - MANIHIKI II Leg 2 The Manihiki Plateau - Origin, Structure and Effects of Oceanic Plateaus and Pleistocene Dynamic of the West Pacific Warm Water Pool, 19.11.2012 - 06.01.2013 Suva / Fiji – Auckland / New Zealand, Eds.: R. Werner, D. Nürnberg, and F. Hauff and the shipboard scientific party, 176 pp, DOI: 10.3289/GEOMAR_REP_NS_6_2013
7	RV SONNE Fahrtbericht / Cruise Report SO226 – CHRIMP CHatham RIse Methane Pockmarks, 07.01. - 06.02.2013 / Auckland – Lyttleton & 07.02. – 01.03.2013 / Lyttleton – Wellington, Eds.: Jörg Bialas / Ingo Klaucke / Jasmin Mögeltönder, 126 pp, DOI: 10.3289/GEOMAR_REP_NS_7_2013
8	The SUGAR Toolbox - A library of numerical algorithms and data for modelling of gas hydrate systems and marine environments, Eds.: Elke Kossel, Nikolaus Bigalke, Elena Piñero, Matthias Haeckel, 168 pp, DOI: 10.3289/GEOMAR_REP_NS_8_2013
9	RV ALKOR Fahrtbericht / Cruise Report AL412, 22.03.-08.04.2013, Kiel – Kiel. Eds: Peter Linke and the shipboard scientific party, 38 pp, DOI: 10.3289/GEOMAR_REP_NS_9_2013
10	Literaturrecherche, Aus- und Bewertung der Datenbasis zur Meerforelle (Salmo trutta trutta L.) Grundlage für ein Projekt zur Optimierung des Meerforellenmanagements in Schleswig-Holstein. Eds.: Christoph Petereit, Thorsten Reusch, Jan Dierking, Albrecht Hahn, 158 pp, DOI: 10.3289/GEOMAR_REP_NS_10_2013
11	RV SONNE Fahrtbericht / Cruise Report SO227 TAIFLUX, 02.04. – 02.05.2013, Kaohsiung – Kaohsiung (Taiwan), Christian Berndt, 105 pp, DOI: 10.3289/GEOMAR_REP_NS_11_2013
12	RV SONNE Fahrtbericht / Cruise Report SO218 SHIVA (Stratospheric Ozone: Halogens in a Varying Atmosphere), 15.-29.11.2011, Singapore - Manila, Philippines, Part 1: SO218- SHIVA Summary Report (in German), Part 2: SO218- SHIVA English reports of participating groups, Eds.: Birgit Quack & Kirstin Krüger, 119 pp, DOI: 10.3289/GEOMAR_REP_NS_12_2013
13	KIEL276 Time Series Data from Moored Current Meters. Madeira Abyssal Plain, 33°N, 22°W, 5285 m water depth, March 1980 – April 2011. Background Information and Data Compilation. Eds.: Thomas J. Müller and Joanna J. Waniek, 239 pp, DOI: 10.3289/GEOMAR_REP_NS_13_2013

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No.	Title
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